

# BERGEY'S MANUAL

# DETERMINATIVE BACTERIOLOGY

#### $\mathbf{B}\mathbf{Y}$

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### SIXTH EDITION



THE WILLIAMS & WILKINS COMPANY
1948

# First Edition, August, 1923 Second Edition, December, 1925 Third Edition, January, 1930 Fourth Edition, March, 1931 Preprint of pages ix + 79 of Fith Edition, October, 1938 Fith Edition, April, 1939

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Made in United States of America

Published January, 1918 Second Printing, September, 1918

> COMPOSED AND PRINTED AT THE WAVERLY PRESS, INC. III. Royal and Guillord Aves Baltimors, Md., U. S. A.

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Nitrobacteriaceae Pseudomonadaceae Chromobacterium Methanococcus Pediococcus Sarcina

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Caulobacternneae Chlamydobacteriales

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Indexes

How Bacteria Are Named and Identified Etymology

Burkholder, Walter IL.

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Myxobacteriales
Pseudomonadaceae
Corynebacterium

Erwinsa Baeterium

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Chapman, Orren D.	Klebsiella	457
	Donoransa	559
Chester, F. D.†	Erwinia	463
	Bacillus	704
Clise, Eleanore H.	App. 3. Micrococcus	252
,	Pasteurella	546
	App. 1. Bacteroides, 575; App. Eubacteriineae, 692,	
	App. Nocardia, 915; App. Streptomyces, 967; and	
	App. Spirochaetales, 1051	
Conn. H. J.	Nitrobacterraceae	69
	Agrobaclerium	227
	App. 3 Corynebaelerium	
	Alcaligenes	
Davis, Cordon E.	Borrelia	
Dienes, Louis	Borrelia Borrelomycciaceae Salmonella	
Edwards, P. R.	Salmonella	
Evans, Alice C	Parvobacteriaceae.	545
Fred, E. B.	Phiabian	223
Hagan, W. A.	Rhizobium Parvobacteriaecae	545
Hall, Ivan C	Anaerobic section Micrococcus, 246; Neisseria, 255;	VIJ
nan, Ivan O	Veillonella, 302; Diplococcus, 30S; and Strepto-	
	coccus, 328	
Hanks, John H.	Mycobacterium	876
Harvey, Philip	Pasteurella ,	
Haynes, Wm C.	Vibrio ,	
-	Spirillum	216
Henrici, A. T t	Caulobacterimeae	
	Nocardia	892
	Actinomyces	925
	Sirépiomuces	929
	Chlamydobacteriales	981
Hitchens, A Parker	Chlamydobacteriales Vibrio Mimeae	192
	Mimeae	595
	Editor Supplement I, 1082, II, 1125 and III, 1287	
Hitchner, E R.	Aeromonas	101
Hofer, A. W.	Azotobacteriaceae	219
Holmes, Francis O	Virales	1200
Hucker, G J.	Mierococcus	235
	Gaffkya	283
	Streptoccecus .	312
	Leuconostoc	346
Huddleson, I. F.	Brucella	560
Johnson, Frank H.	Phasphorescent Bacteris	
Kauffmanu, F.	Salmonella	492
Kelly, G. D.	Acetobacter	179
	Bacteroides	
	Noguchia	592
Kirby, Harold	App. 1. Rickettsiales	1121
Meyer, K. F.	Pasteurella ,	545

	Neisseriaceae 29i	
Murray, E. G. D.	Diplococcus	5
	Streptococcus	2
	Streptococcus	i.
	Corynebacteriaceae	5
	Parvobacteriaceas	£
	Parvobacteriaceas	6
Pederson, C. S	Spirochaetates 34 Leuconostoc 34	9
Ledetagn't or a		1
	Microbaclersum	
	Butyribacterium 38	n.
m is or Makabani A	Butyribacterium	
Peshkoff, Michael A	Hemophilus 64f	ř
Pittman, Margaret		
Rahn, Otto	Chlamudazaaceat	
Rake, Geoffrey		
Reed, Guilford B	Mycobacteriaceae	
Rettger, L. F.	C	ı.
Robinson, George H †		
Roy, T. E.		
Rustigian, Robert		12
Sherman, J. M.	Bireproceed	19
Smith, Frederick		
	Snigetta	04
Smith, N. R.	Bacillus	70
Speck, M. L		63
Spray, R. S.	Clostridium 10	
Stanier, R Y.	Cytophagaceae. 10	18
		69
Starkey, R. L.	Nitrobacteriaceae 392, 440 Insect Microbiology 10	sf.
Steinhaus, Edward A.		
0.101		186
Stuart, C. A	Proteus	231
Tobie, W. C.		72
Van Niel, C. B	Propionibactersum	338
( Dit Aire )	Rhodobacterisneae	988
	Beggnatoaceae	997
	Achromatiaceae	179
Vaughn, Reese		692
Waksman, Selman A.	Actinomycetaccae	929
11 15 600 11 11 11	Streptomycetaceae	100
Weinman, David	Bartonellaccae	516
Welsh, Mark	Pasteurella	411
Yale, M. W.	Escherichia .	453
A die,	Aerobacter	480
	Proleus	200
ZoBell, Claude E	Deviloribrio	
Lopen, Ctadde 25	Marine Microbiology 107, 418, 43	

<sup>†</sup> Deceased, October, 1915.



#### PREFACE TO SIXTH EDITION

More than the usual amount of time and effort has been given toward making this new edition of Bergey's Manual useful. The volume has been completely revised and is reset in double column format so that each page carries about 20 per cent more type than the pages in the fifth edition. Those who are interested in special groups of bacteria will find something new in the presentation of the relationships in every genus. Because of our rapidly expanding knowledge, changes in the outline classification and text were made necessary. These changes have in every case been made by specialists in consultation with the Editorial Board. Every specialist possesses first hand knowledge of the species in the group that he or she has reviewed.

Because increasing knowledge has shown the fission fungi to be a larger and more diversified group than previously realized, the number of species described has increased from 1335 in the fifth edition to 1630 in the present edition of the Manual. This number does not cover all of the descriptions found in the literature for, as in all other fields of biology, mony of the descriptions are so inadequate that the species described connot now be identified. Many descriptions are obvious or probable duplications of previous descriptions while still others are based on nothing more substantial than the author's belief that he had something new, he hoving made but little effort to compare his cultures with those found by previous investigators. An indication of the large number of inadequate descriptions will be found by referring to the material in the appendixes to the various groups, and to the index where synonyms and incompletely described species are shown in itnlies.

The large number of these poorly described species suggests that there has been much unsatisfactory work done in the field of bacteriological taxonomy. Progress in this inadequately developed field is needed as it would help to clarify the approach to desirable research in many fields of bacteriology.

It is believed that both teachers and investigators will find the new Source and Habitat index useful. It is important to know what organisms have been described from any given babitat in determining the identity of a described species or whether a given species is new.

The future development of taxonomic work holds several interesting possibilities of increased international cooperation such as between the various National Type Culture Collections and within the International Association of Microbiologists. The Trust Funds provided through the generosity of Dr. Bergey before his death have been used in developing the present edition of the Manual and future funds are to be used in the same way under the management of a self-perpetuating Board of Editor-Trustees.

We are all under obligation to those who have given so freely of their time and special knowledge in preparing this edition of the Manual. Moreover the Editor-in-Chief is under special obligation to his wife, Margaret Edson Breed who has earried the burden of the indexing; to Mrs. Eleanore Heist Clise who has given invaluable service in bibliographical research, in proof reading and other ways; and to his secretary, Miss Mande Hogan, who has cared for many difficult manuscripts and a voluminous technical correspondence.

Many binomials not previously mentioned in the Manual will be found in the Index of Genus and Species Names. Each new name means that there is a new bibliographic reference in the text. Practically all of the incomplete references of previous editions and all new references have been examined in the original, something that is essential in all accurate taxonomic work. The index of names is the most complete list that has appeared in the literature and should always be consulted before new genus or species names are proposed.

This edition of the Manual has been more than four years in press, thanks to the care that has been taken to make it complete and useful. Throughout, the Editorial Board has had the cooperation and understanding help of the publishers of the book who themselves have been forced to meet and overcome the trying difficulties of the war years.

The plan of the present book is such that it will be found useful both to teachers and research workers.

> RODERT S. BREED, Chairman E. G. D. MURRAY A. PARKER HITCHENS Board of Editor-Trustees.

April, 1947.

#### PREFACE OF FIRST EDITION

The elaborate system of classification of the bacteria into families, tribes and genera by a Committee on Characterization and Classification of the Society of American Bacteriologists (1917, 1920) has made it very desirable to be able to place in the hands of students a more detailed key for the identification of species than any that is available at present. The valuable book on "Determinative Bacteriology" by Professor F. D. Chester, published in 1901, is now of very little assistance to the student, and all previous classifications are of still less value, especially as earlier systems of classification were based entirely on morphologic characters.

It is boped that this manual will serve to stimulate efforts to perfect the classification of bacteria, especially by emphasizing the valuable features as well as tho weaker points in the new system which the Committee of the Society of American Bacteriologists has promulgated. The Committee does not regard the classification of species offered here as in any sense final, but merely a progress report leading to more satisfactory classification in the future.

The Committee desires to express its appreciation and thanks to those members of the society who gave valuable aid in the compilation of material and the classification of certain species. . . .

The assistance of all bacteriologists is earnestly solicited in the correction of possible errors in the text; in the collection of descriptions of all bacteria that may have been omitted from the text; in supplying more detailed descriptions of such organisms as are described incompletely; and in furnishing complete descriptions of new organisms that may be discovered, or in directing the attention of the Committee to publications of such newly described bacteria.

DAVID H. BERGEY, Chairman FRANCIS C. HARRISON ROBERT S. BREED BENNARD W. HAMMER FRANK M. HUNTOON Committee on Manual.

August, 1923.



## CONTENTS

Introduction	
Historical Survey of Class Centions	•
How Bacteria are Named and Identified	,
Bules of Nomenclature	
Class Schromscetes Nazeli	. 6
Order L. Eubacteriales Backanan	
Suborder I Eulere'eveneur Dire ! Marray and Hatel en	67
Pamily 1 Astro actorioceae Burl anan	63
Tribe I Sate lasteriese Wanslow et al.	
Grane I Virgo moral Wicherstein	יה
Genus II Aures ever a Winografile	71
Genus III Agreering Was agradely	71
Genus W. Aitout earns Minigra lets	- 77
Grane V Astronous II Was gradely	73
Grave VI. Nation's for Winners felo	7.6
Genus VII Vitrospins II Winters feld	
Tribe II Hylenger maratere Pallager	10
Genus I Histogram + 21 this Jenson	73
Tribe III Thiotecillese berges Director I Mares	- 1



CONTENTS MIN

Family XI. Partebutteriotest Rabn.		30
Tribe 1. Partewellege Castellani and Chalmers		
Genus 1, Parteueella Trevisan	• • • • • • • • •	310
Genus II Malleomyres Hallier	,	850
Genus III Actinstantla Brungt,		32
Appendix Genus A. Incorpor Anderson et al.		2.54
Tribe H. Beucellece Bergey, Breed and Murray		260
Genus L. Brurell's Meyer and Shan		2/31
Tribe III Bactero fere Brest Murray and Hitchene		37.4
Genus 1 lizetero, fee Castellant and Chalmers		201
Genus II Fusebacterson Knert		261
Appendix Genus A Lunforme Heelling		4.53
Tribe IV. Hemogration Waterow et al		2.54
Genus 1 Hemophilus Wittelms et al.		21
Genus II Merarella limen		40
Genus III Negactia Oliteky, Syrection and Tyles		35
Genus IV. Dialities Pergevet al		274
Appendix Tale Marco Delta !		233
Family XII. Ratteriorese Celin		2.14
Genus I Bacterium Il rentweg		7. 7.
Hulynticta		
Kutha Tirana		(11)
Cellulomonas Berger et al		£12
Street goods of copum trotter at 121 am		623
Agail artenim Azzet		1:1
D'or Ameterson Beyern ch		121
Wellow Lastern = 1 Linear et l Cen Nort		

xii CONTENTS

Genus 11. Gelly a rie return	-
Genus III. Sarcina Goodsir	283
Subrenera:	
Zymosarcina Smit.	283
Methanosarcina Kluyver and Van Niel	283
	285
Sarcinococcus Breed	
Sporosarcina Orla-Jensen	283
Family VI. Neuszeriaceae Prévot	293
Genus I. Neisserza Trevisan	298
Genus II. Veillonella Prévot	302
Family VII. Lactobacteriaceae Orla-Jenson	303
Tribe I Strentacaccene Trevisan	30
Tribe I. Steeptococceae Trevisan.  Genus I. Diplococcus Weichselbaum	303
Genus II. Streptococcus Rosenbach	312
Genus 11. Europiotoccus Rusenbacu	341
Genus III Leuconostoc Van Tieghem	
Tribe II. Lactobacilleae Winslow et al	349
Genus I. Lactobacillus Beijerinek	349
Sub-genera ·	
Thermobacterium Orla-Jeasen	35
Streptobacterium Orla-Jensen	356
Betabactersum Orla-Jonson	35
Appendix. Genus A Leptotrichia Trevisan	26
Genus II Microbactersum Orla-Jensen	370
Genus III Propionibacterium Orla-Jensen	373
Genus IV. Butyribacterium Barker	379
Family VIII. Corynebacteriaceae Lehmana and Neumann	38
Genus I. Corynebacterium Lehmann and Neumann	381
	405
Genus II. Listerta Pirie	
Genus III Erysipelothriz Rosenbach	410
Family IX. Achromobacteriaceae Breed	412
Genus I Alkalıgenes Gastellani and Chalmers	412
Genus II Achromobacter Bergey et al	41
Genus III Flacobacterium Bergey et al. Family X. Enterobacteriaceae Rahu	42
Family X. Enterobacteriaceae Rahn	447
Tribe I. Eschericheae Bergey, Breed and Murray	44
Genus I. Escherichia Castellani and Ghalmers	44
Genus II. Aerobacter Beijerinek	45
Genus III Klebstella Trevisan	457
Appendix Genus A Paracolobactrum Borman, Stuart and	401
Wheeler	45
Tribe II. Erwincae Winslow et al.	46
Genus I. Erwinia Winslow et al	463
Tribe III Serrateae Bergey, Breed and Murray	475
Genus I. Serratia Bizia emend. Breed and Breed	475
Tribe IV. Proteae Castellani and Chalmers	486
Genus I. Proleus Hauser	48
Tribe V. Salmonelleae Bergey, Breed and Murray	493
Genus I. Salmonella Lignières	49
Genus 11. Shigella Castellani and Chalmers	538
Sens II. Daigetti Castellitti anti Giatmers	000

223

CONTENTS

XY

Family III. Oscillorpiracese Perskoff	than
Genus I Genillespira Chatton and Person	, the
Family IV. Carpert process Pertholi	, tent
Genus I Carportaren Perticil	2.01
Order W. Myzol acteriales Jalia	19.3
Family I Cyrophogorese planter	1212
Genus I Caterfara Stanier	14:2
Family II Arctongracese Jahn	fot:
Genus I Archangiam Jahn	1117
Genus II Stefangiam Jalin	1222
Family III Separate in Ja'n	1921
Genus I Serargive Jahn	1 121
Family IV Pet, argainst Jahn	1,522
Genue I Patentinan Jahre	1225
Genus II Strengum Jahn	11.27
Genus III Metadorman dain	1.41
Genus IV Polymum Ja'n	27514
Genus 3 Cheeter er Bergeles or & Curtis	1 111
Family V Mercrecore Jat.	2521
Genus 1 Mariewrus Phaster	2/41
Genus II Chienden eine le' :	2011
Gerne III Arguerers Jahr	1117
Genus IV Springs of the ter	1 :1 :
Order V. Spring acceles Part at an	5.44
Partily I System determs have regreted	21/2
Gerge I Spire tain Price wie	\$ **
Getue II Sopreeperator my	2.1.2
Genus III Contragos for ex	175
Parrilly II Tesponen storees better \$15	2.74
Germe ! Pretelia fine enger'et	1.054
Gerra II Trep erma her s	: 11
Corne 111 for errer backers	. •

Xiv CONTENTS

Genus V Thiothece Winogradsky		816
Genus VI Thiocystis Winogradsky		846
Genus VII Lampracystis Schroeter		817
Genus VIII Amoebobacter Winogradsky		848
Genus IX. Thropolycoccus Winogradsky		
Genus IX. Thropolycoccus Winogradsky Genus X. Throspirillum Winogradsky		850
Genus XI Rhabdomonas Cohn		853
Genus XII. Rhodothece Mohsch		855
Genus XIII. Chromatium Perty		856
Family II. Athorhodoceae Mohsch		861
Genus I. Rhodopseudomonas Kluyver and Van	Niel emend. Van	
Niel		861
Genus II. Rhodospirillum Molisch		866
Family III. Chlorobacterraceae Geitler and l'ascher		\$69
Genus I. Chlorobium Nadson.	, ,	869
Genus II. Pelodictyon Lauterborn		870
Genus III. Clathrochloris Geitler.		872
Genus IV. Chlorobacterium Lauterborn	,.	872
Genus V. Chlorochromatium Lauterborn		873
Genus VI. Cylindroglosa Perfiliew.		873
Order II. Actinomycetales Buchagan		875
Family I Mycobacteriaccae Chester.		875
Genus I Mycobacterium Lehmana and Neumann		876
Family II. Actinomycetaceas Buchanan		
Genus I Nocardia Trevisan .		
Genus II Actinomyces Harz		925
Family III. Streptomycetaceae Waksman and Henrica		020
Genus I. Sireptomyces Waksman and Henrici	. ,,,,	929
Genus II Micromonospora Orskov		978
Order III. Chlamydobacteriales Buchanan		981
Family I Chlamydobacteriaceae Migula		981
Genus I. Sphaerotilus Kutzing		
Genus II. Clonothriz Roze		983
Genus III. Leptothrix Kutzing		
Family II Crenothrichaceae Hansgirg		
Genus I Crenothriz Cohn		937
Family III Beggiatoaceae Migula		
Genus I. Thiothrix Winogradsky		988
Genus II Beggiatoa Trevisan		990
Genus III. Theospirellopsis Uphol	,	993
Genus IV. Thioploca Lauterborn	•	993
Appendix Family Achromatiaceae Massart		997
Genus I. Achromatium Schewinkoff	•	997
Genus II. Thiovulum Hinze		1000
Genus III Mocromonas Utermohl and Koppe		1000
Appendix: Order Caryophanales Peshkoff Family I. Pontothricaceae Peshkoff		1002
Genus I Pontothrica Nadson and Krassilnikow		1002
Family II. Arthromitaceae Peshkoff		1002
Genus I. Arthromitus Leidy		1002
Genus II. Coleomilus Dubosca and Grassé		

#### INTRODUCTION

#### SUGGESTIONS FOR THE USE OF THE MANUAL IN CLASSIFYING UNKNOWN ORGANISMS

No organism can be classified before we have determined, through detailed study, its morphological, cultural, physiological and pathogenic characters.

The characters used in the keys to orders, families and genera may ordinarily he determined by the use of a dozen or more of the procedures described in the Manual of Pure Culture Study issued by the Committee on Bacteriological Technic (H. J. Conn, Chairman, Geneva, New York) of the Society of American Bacteriologists. More complete examinations must be made as indicated in the Manual of Pure Culture Study, and in the Descriptive Charts which accompany this Manual where it is desired to identify individual species. These tests must be made if bacteria are to be accurately identified and described.

It is urged that beginning students be taught the technics necessary for the identification of species in the hope that the taxonomic work of the future may be placed on a more satisfactory basis.

After a complete study of the characters of the organism has been made, turn to page 65 and ascertain first in which order the organism belongs. When the order and suborder (if necessary) have been ascertained, turn to the page of the Manual on which the key to that order or suborder is given. In this key ascertain the family or subfamily to which the organism belongs.

When the family or subfamily has been decided on, again refer to the page of the MANUAL on which the key to that family or subfamily is given.

In this key ascertain the tribe to which the organism belongs.

When the tribe has been decided on, again find the page of the MANUAL on which the key to the tribe is given. In this key ascertain the genus to which the organism belongs.

When the genus has been decided on, again refer to the page of the MANUAL on which the key to that genus is given. In this key, trace out

the species under investigation

For example, if one wishes to trace a short, peritrichous, Gram-negative, non-spore-forming rod that grows well on ordinary culture media at 37°C, fermenting glucose and lactose with production of acid and gas, not liquefying gelatin, producing no pigment on any culture medium, with negative reaction for acetylmethylearbinol, producing indole and reducing uitrates, consult the key to the orders on page 65.

xvi contents

	1105
Supplement II	1120
Order Virales Breed, Murray and Hitchens	1120
Suborder I. Phagineae Holmes	1120
Family I. Phagaceae Holmes	1123
Genus I. Phagus Holmes	
Suborder II Phylophagineae Holmes	
Family I. Chlorogenaceae Holmes	
Genus I. Chlorogenus Holmes	
Genus II. Carpophthora McKinney	
Genus III. Morsus Holmes	
Genus IV. Aureogenus Black	
Genus V. Galla Holmes	
Genus VI. Fractilinae McKinney	1159
Family II. Marmoraceae Holmes Genus I. Marmor Holmes Genus II. Acrogenuz Holmes Genus III. Cornum Holmes	
Genus I. Marmor Holmes	
Genus II. Acrogenus Holmes	
Genus IV Nanus Rolmes	1206
Genus V. Rimocortius Milbrath and Zeller	1203
Genus VI. Adelonosus Brierley and Smith	1211
Family III Annulaceae Holmes	1212
Genus I. Annulus Holmes	1212
Family IV. Rugaceue Holmes	
Genus I Ruga Holmes	1218
Family V. Sarotoceae Holmes	
Genus I Savoia Holmes	
Family VI Lethaceae Holmes	
Genus Y Lethum Holmes	
Suborder III. Zoophagineae Holmes	1225
Family I. Borrelinaceae Holmes	1225
Genus I. Borrelina Paillot	
Genus II. Morator Holmes	
Family II Borreliotaceae Holmes	1229
Genus I. Borreliota Goodpasture	
Genus II Briareus Holmes	
Genus III. Scelus Holmes	
Genus IV Hostis Holmes	
Genus V Molster Holmes	
Family III. Erronaceae Holmes	
Genus 1 Erro Holmes	
Genus II Legio Holmes	1257
Genus III Formido Holmes	
Family IV. Charonaceae Holmes	1265
Genus I. Charon Holmes	1265
Genus II. Tarpera Holmes	
Genus III Torior Holmes	
Family V Trifuriaccae Holmes	
Family VI. Rabulaceas Holmes	1284
Genus I Rabula Holmes	1284
	1287
Family Borrelomycetaceae Turner	
Genus I. Ascacoccus Borrel et al	1291

#### INTRODUCTION

#### SUGGESTIONS FOR THE USE OF THE MANUAL IN CLASSIFYING TINKNOWN ORGANISMS

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For example, if one wishes to trace a short, peritrichous, Gram-negative, non-spore-forming rod that grows well on ordinary culture media at 37°C. fermenting glucose and lactose with production of neid and gas, not liquefying gelatin, producing no pigment on my culture medium, with negativo reaction for acetylmethylearbinol, producing indole and reducing uitrates, consult the key to the orders on page 65.

In this key examine A. Cells rigid, not flexuous. This indicates our or-

We next examine 1. Cells single, in chains or masses. Not bronching and mycelial in character. Not arranged in filaments. Not acid fast. As the organism in question occurs as single cells or at most as short chains and is not acid fast, this indicates that it belongs to the Order Eubacterioles.

We now examine a. Do not possess photosynthetic pigments. Cells do not contain free sulfur. As our organism is unpigmented and the cells do not contain free sulfur, this indicates that our organism belongs to the Sub-order Eubacteriineae. We note that the key to this suborder is on page 67.

We next attempt to ascertain the family to which the organism belongs by tracing it through the key to the families of the Sub-order Eubacteriineae, p. 67.

I. No endospores indicates our organism. We proceed to A. Can decelop on inorganic media. As the organism cannot grow without organic carbon, we turn to B. Cannot develop on inorganic media.

This corresponds with the physiology of our organism; so we turn to 1. Polor flagellate, etc. As our organism is peritrichous, we proceed to 2. Large oral, pleemarphic cells sometimes almost yeast-like in appearance. Free living in soil. Fiz free nitrogen. As this does not correspond with the morphology or physiology of our organism, we next examine 3. Peritrichous or non-motile rods, and cocci. This corresponds with the characteristics of our organism.

We turn to a. Helerotrophic rods which may not require organic nitrogen for growth. Usually mottle with one to six or more flagella. Usually form nodules or tubercles on roots of plants, or show violet chromogenesis.

This again does not indicate our organism; so we turn next to an. Heterotrophic rods or eocti which utilize organic nitrogen and usually carbohydrates. As our rod-shaped organism prefers a medium containing organic nitrogen, we proceed to b. Spherical cells in masses, tetrads and pockets.

This does not correspond to the morphology of our organism, and we now proceed to bb. Spherical cells which grow in poirs and chains; and rods. This includes our rod-shaped organism; so we turn to c. Gram-positive cocci and rods. Non-motile. Since these are not the characteristics of our organism, we turn to cc. Gram-negative rods. When motile, from four to many pertrichous flagello.

Our organism is Gram-negative and peritrichous; so we proceed to d. Grow well on ordinary media containing peptone Aerobic to focultative anaerobic.

This corresponds with the characteristics of the organism we have studied; so we turn next to e. Gram-negative, straight rods which ferment

sugars with the formation of organic acids. This again corresponds with our organism. We turn next to f. Produce tutle or no acid from litmus milk. This does not correspond with the characters we have determined for our organism. We proceed to ff Produce  $CO_2$  and frequently visible gas  $(CO_2 + H_1)$  from glucose. Reduce nitrates, etc

Our organism produces visible gas from glucose and reduces nitrates. This indicates that it belongs to Family X. Enterobacteriaceae, p. 443.

This appears to fit our unknown organism. We now refer to page 443 on which the key to the Family Enterobacteriaceae is found. In this key we ascertain the Tribe to which our organism belongs. 1. Ferment glucose and lactose with the formation of acid and visible gas. Usually do not liquefy gelatin Tribe I. Eschericheae.

This corresponds with the characters exhibited by our organism. We refer to the key for Tribe I. Escherichea on the same page. 1. Melhyl red test positive. Voges-Proskauer test negative. Salts of ciric acid may or may not be used as sole source of carbon. Genus I. Escherichia, p. 444.

This description appears to correspond with that of our unknown or-

This description appears to correspond with that of our unknown organism. We find the key to the species of Genus Escherichia follows the key to the Tribe Eschericheae. On tracing our organism in this key we find that it corresponds to Escherichia coli. A brief description of this organism is found on the same page.

\*In the use of keys for identifying bacteria, the student is confronted with two difficulties, both based primarily on lack of knowledge and experience. The first is insufficient knowledge concerning the morphology, physiology, possible pathogenicity and habitat of the microorganisms that are to be identified. This may be due to careless observations or to poor training in the special techniques that must be used in determining the identity of a given bacterium

The second difficulty in the use of a key comes from inexperience in the use of technical terms; that is, the student may not thoroughly understand the meaning of the statement in the key and so cannot follow a route through the key with certainty. For example in the keys used here, the student must know the difference (1) between chains of cells which are composed of dividing cells which do not separate at once, and (2) filaments which are composed of dividing cells which remain more permanently to-gether and are normally finttened against each other on adjacent sides. They may show some differentiation into hold fast cells and reproductive cells (conidia), (3) Both chains of cells and filaments are to be distinguished from the mycelial threads found in Actnomycelaccae. These are unseptate and branching with a true branching.

<sup>\*</sup> Condensed and paraphrased from Hatchcock's Descriptive Systematic Botany, New York, 1935.

The student should be warned not to take descriptions in the Manual too literally or too rigidly. Descriptions are usually drawn to represent average findings. Especially among bacteria, characters such as sugar fermentations, gelatin liquefaction, presence or absence of flagella and other things will vary. Sometimes these variations are due to slight, possibly unrecognized variations in the techniques used in determining these characters. Real knowledge of the characteristics of species may also be very incomplete. This is true not only of the physiological activities of these microorganisms; but also in regard to such detectable structural features as the number and position of flagella. Dark field movies of motife cells and photographs taken with the recently developed electron microscope are revealing new and heretofore unsuspected facts regarding structural features.

Source and habitat data are frequently helpful in aiding the student to recognize species of bacteria and may indicate that the pathogenicity of the culture in question may need to be tried on some specific animal or plant. By habitat is meant the kind of a place in which the organism normally grows; by source, the particular material and place from which the culture was obtained. This source may or may not indicate the natural habitat. The source of cultures is invariably more limited in scopo than the habitat as bacteria normally occur wherever their particular habitat may be found in a world wide distribution.

The student is also reminded that it is impracticable to note all exceptions in keys. Bacteria like other living things are classified according to a combination of characters, not according to some single character, and exceptions to the characters noted in the keys will occur in nature. These may not be known to or may have been overlooked by the author of the key. On the other hand, the importance of such exceptions should not be overemphasized and the student would do well to use the key as if there were no exceptions.

#### HISTORICAL SURVEY OF CLASSIFICATIONS OF BACTERIA, WITH EMPHASIS ON OUTLINES PROPOSED SINCE 1923\*

There have been numerous attempts to arrange the species of bacteria in natural systems of classification. The first simple system of Muller (Vermium terrestrium et fluviatilium, 1773) which he developed further a few years later (Animalcula infusoria fluviatilia et marina, 1786) listed but two genera (Vibrio and Monas) that included organisms that would today prohably be accepted as bacteria. Polyangum Link (Mag d. Ges. Naturforsch. Freunde zu Berlin, 3, 1809, 42) is apparently the oldest of the generic terms retained in its original meaning for a bacterial genus while Serratia Bizio (Bihlioteca italiana o sia giornale do lettera, scienze ed arti, 30, 1823, 288) was proposed only fourteen years later.

Systems of elassification developed after 1773 are given in complete outline form in the first edition of the Manual (1923) and this section of the Manual was reprinted without material change in the second (1925) and third (1930) editions. While it is not felt to be necessary to repeat these outlines in their entirety, sufficient reference is made below to permit the student to trace the origin of generic terms that are no longer commonly found in classification outlines. No attempt has been made to include reference to other little used generic terms except as they appear as synonyms in the descriptive portion of the Manual. For the origin of generic terms proposed before 1925, see Enlows (The Generic Names of Bacteria, Bull. No. 121, Hygienic Laboratory, Washington, D. C., 1920) and Buchanan (General Systematic Bacterology, Baltimore, 1925).

Bory St. Vincent (Microscopiques, Dictionnaire classique d'histoire naturelle, 10, 1826, 533) introduced the genetic terms Spirilina, Melanella, Lactimatoria and Pupella and accepted Vibro for microorganisms, some of which must have been bacteria. None of these terms, except Vibrio, are in current use for bacterial groups.

Three of the terms accepted or proposed by Ehrenberg (Die Infusionstierchen als volkommene Organismen, Leipzig, 1838); namely, Vibrio, Spirillum and Spirochaeta, are still used The generic term Bacterium proposed first by Ehrenberg in 1828 (Symbolae Physicae seu Icones et Descriptiones Animalium Evertebratorum Separasitis Insectis quae ex Itinere per Africam Borealem et Asiam Occidentalem, IV. Evertebrata, Berlin) to include but a single species Bacterium triloculare from an oasis

<sup>\*</sup>Contributed by Prof. R. S. Breed, New York State Experiment Station, Geneva, New York, July, 1935; revised, September, 1943.

11th Ann. Rept., 1899, 36), or in his complete outline (Manual Determ. Bact., 1901). Almost all of the generic terms found in his outlines are still in current use.

The term Aplanobacter suggested by Erwin F. Smith (Bacteria in Relation to Plant Diseases, 1, 1905, 171, Washington) was accepted by certain American phytopathologists for a time but has never come into general use.

Because other differences between the non-chromogenie and chromogenie micrococci are unimportant, two generie terms, Albococcus and Aurococcus, suggested by the Winslows (Science, 21, 1905, 669; Systematic Relationships of the Coccaccae, New York, 1908) have not come into general use. They also suggested Rhodococcus to include Rhodococcus roseus and R. fulvus apparently without realizing that Zopf (Ber. d. deutsch. bot. Gesellsch. Berlin, 9, 1891, 28) had previously used the same term for Rhodococcus crythromyza and R. rhodochrous. Hansging (Engler and Prantl, Die naturlichen Pflanzenfamilien, 1, 1a, 1895, 52) had also used it previously to designate a sub-genus of the green algae, and later Molisch (Die Purpurbakterien, Jena, 1907, 20) used Rhodococcus for a genus of the purple bacteria to include Rhodococcus capsulatus.

In his complete outline of the classification of bacteria presented in 1909, Orla-Jensen (Cent. f. Bakt., II Abt., 22, 1909, 305) introduced many new generic terms in an effort to create a nomenclature that appeared to him to express the natural relationships of bacteria more satisfactorily than names previously suggested had done. Thus he used the suffixes coccus and sarcina for spherical bacteria and monas for all genera known to be lophortichous or so related to these types that they were regarded as essentially lophotrichous in nature. In the same way the suffix bacterium was used for genera of non-spore-forming rods that were regarded as essentially peritrichous in nature, and the suffix bacillus for similar spore-forming rods. As, however, subsequent investigators have (1) accepted the priority rule, (2) felt that it was impossible to recognize the type of motility found in the ancestry of truly non-motile groups, or (3) felt that other characters were more fundamental than those selected by Orla-Jensen, many of these terms have not been generally used by later workers.

Among the little used terms suggested or accepted by Orla-Jensen are: Acetimonas, Natromonas, Azolomonas, Rhicomonas, Corynemonas, Mycomonas, Sulfomonas, Thiomonas, Thococcus, Rhodomonas, Rhodogictyon, Amoebomonas, Rhodopolycoccus, Rhodosarcina, Spirophyllum, Denitromonas, Liquidomonas, Liquidomonas, Liquidococcus, Solidococcus, Solidoc

While Nitromonas is not new, it is redefined as a synonym of Nitrobacter Winogradsky (Arch. Sci. Biol. St. Petersburg, 1, 1892, 87), rather than as a synonym of Nitromonas Winogradsky (Ann. Inst. Past., 3, 1890, 268). Spirophyllum is from Ellis (Cent. f. Bakt., II Abt., 19, 1907, 507).

In a later monograph on The Lactic Acid Bacteria (Mem. d. Acad. Roy. Sci. et Lettres de Danemark, Sect. Sci., 8 Sér., 5, 1919, No. 2) Orla-Jensen proposes the following additional generic terms: Belacoccus, Belabacterium, Streptobacterium, Thermobacterium and Microbacterium. The term Tetracoccus is introduced with a meaning different from that given the term previously by v. Klecki (Cent. f. Bakt., 15, 1894, 354).

Buchanan prepared an outline classification in 1916 (Jour. Bact., 1, 1916, 591; 24, 1917, 155, 347, 603, 3, 1918, 27, 175, 301, 403, 401, 591) which was utilized in part hy the group of which he was a member (Winslow, Broadhurst, Buchanan, Krumwiede and Smith) in their preliminary Report to the Society of American Bacteriologists (Jour. Bact., 2, 1917, 552) and in the final report by Winslow, Broadhurst, Buchanan, Krumwiede, Rogers and Smith (Jour. Bact., 2, 1920, 191).

Although prepared earlier, some parts of the Buchanan outline were not published until after the first Winslow et al. report. As these reports formed the most important hasis for the classification used in the first edition of the Manual, it is natural that the generic terms utilized are, in general, the same as those used in the Manual.

Generic and subgeneric terms included by Buchanan that are not used in the present edition of the MANUAL are: Paraspirillum Dobell (Arch. f. Protistenk., 24, 1911, 97), Eubacillus Hansgirg (Osterr. Bot. Ztschr., 58, 1888, 264; not Eubacillus Dangeard, Le Botaniste, 2, 1891, 151) and Melabaclerium Chatton and Perard (Comp. rend. Soc. Biol , Paris, 65, 1913, 1232). Siderocapsa Molisch (Ann. Jard. Bot. Buitenzorg, Ser. 2. Supp. 3, 1909, 29) used by Buchanan but dropped by Winslow et al (Jour. Bact., 2, 1917, 549) does not appear in the Manual classification outline until the Present (6th) edition. The term Mycoderma recognized both by Buchanan (Jour. Bact., 3, 1918, 45) and in the preliminary Winslow et al. report (Jour. Bact., 2, 1917, 551) was replaced by the later and more valid term Acetobacter in the final report by Winslow et al. (Jour. Bact., 5, 1920, 201). Pfeifferella Buchanan (Jour. Bact., 3, 1918, 51) which is used in the three outline classifications under discussion and also in the first, second and third editions of the Manual, appeared in the literature through a clerical error (Buchanan, General Systematic Bacteriology, 1925, 420). It was combined in the fourth edition of the MANUAL with the genus Actinobacillus under the latter name. Nocardia Trevisan (1889) u-cd by Buchanan and in the preliminary report by Winslow et al. (1917) was merged with Actinomyces

Harz (Jahresber. München. Thierarzneisch. for 1877-78, 125) in the final report by Winslow et al. Erythrobacillus Fortineau (Compt. rend. Soc. Biol. Paris, 58, 1905, 104) is used by Winslow et al. (1920) but was not accepted in the first and following editions of the Manual as it is a synonym of the older Serratia Bizio (1823). Moreover, the species which must be accepted as type for the genus (Erythrobacillus puesepticus Fortineau (monotypy)) is a species which has been reported by Breed (Manual, 3rd ed., 1930, 117) to be a variant of the older Serratia marcescens.

One of the most unsatisfactory portions of recent classifications, such as those outlined by Buchanan (1917–18) and by Winslow et al. (1917), is the treatment given the organisms of the coliform-dysentery-typhoid group in that the term Bacterium is retained for these as suggested by Orla-Jensen (1909). A strict limitation of Bacterium to this group gives it a still different meaning from that which it bad had in previous and current classifications, and makes it necessary to find some other place for many other species of Gram-negative, non-spore-forming rods, some of which are well known and well described. The relationships of these miscellaneous species to other non-spore-forming rods is frequently poorly understood. In some cases, further study will probably show that they should be placed in well known and currently recognized genera. In others, further study will probably show that some of these species of non-spore-forming rods should be grouped in new genera.

Winslow et al. (1920) recognized this situation and broadened their definition of Bacterium thereby placing sueb well known species as are included in the colon-dysentery-typhoid group with other species of non-spore-forming rods of quite a different character. For this reason, partial use was made in the first edition of the Manual of the numerous generic terms newly proposed by Castellani and Chalmers (Manual of Tropical Medicine, 3rd ed., 1919) Thus the following new terms were introduced: Alcaligenes, Salmonella, Escherichia and Encapsulatus; and the earlier terms Aerobacter Beijerinck (1900) and Eberthella Buchanan (1918). Later it was found that Encapsulatus was a synonym of Klebsiella Trevisan (1887), so that the latter term was accepted in the second and subsequent editions of the Manual. Shigella Castellani and Chalmers was recognized as distinct from Eberthella in the third and subsequent editions.

Many of the new terms suggested by Castellani and Chalmers were, however, synonyms of earlier valid terms or have not been considered necessary, and so they have not come into general use. These are Nigrococcus, Graciloides, Cloaca, Eberthus, Dysenteroides, Lankoides, Wesenbergus, Balkanella and Enteroides. No new generic terms are given by Castellani and Chalmers in their later report (Ann. Inst. Past., 34, 1920, 600).

Orla-Jensen (Jour. Bact., 6, 1921, 263), in a paper published after the manuscript of the first edition of the Manual was prepared, suggested the use of Colibacterium and Aerogenesbacterium for the two genera in the coliform group and adds quite a number of other new terms formed in accordance with his system of nomenclature. These are, in most cases, synonyms of earlier valid names. The new terms are Coccomonas, Spiromonas (used in a new, different sense from that of earlier authors), Fluoromonas, Photomonas, Pronionicoccus, Buturiclostridium and Putriclostridium.

Many new terms are proposed in the classification drawn up by Heller (Jour. Bact., 6, 1921, 521; and 7, 1922, 1). Details are given in the group of annerobic spore-formers only. Here each of the new generic terms is based on a single species The following outline is given in the first of these papers, two new genera (Rivoltillus and Metchnikovillus) being made the type genera for two new subfamilies Clostridioideae and Putrificoideae. respectively.

Phylum I. Bacteria Class I. Enbacterieae Order 1 Eubacteriales Family 6 (?). Clostridiaceae Subfamily 1. Clostridioidege Subfamily 2. Putrificoideae Order 2 Thiobacteriales Order 3. Chlamydobacteriales Class II. Muxobacterieae

In the more complete outline in the second paper, one generic term (Clostridium) is old, although it is used in a new and restricted sense, while with the exception of the type genera mentioned above, the other terms are new. In the subfamily Clostridioideae, the new terms are Omelianskillus. Macintoshillus, Douglasillus, Henrillus, Flemingillus, Vallorillus, Multifermentans, Hiblerillus, Welchillus, Stoddardillus, Arloingillus, Menerillus and Novillus. Ten new generic terms are used in the subfamily Putrificoideae as follows: Seguinulus, Reghillus, Robertsonillus, Nicollaierillus, Martellilus, Recordillus, Tissierillus, Putrificus, Ermengemillus, and Weinbergillus. As there does not seem to be any good reason for sub-dividing the genus Clostridium in this way, the latter term has been used to cover anacrobic spore-forming rods in all previous editions of the Manual, and is again used in the present edition in this sense rather than with the restricted meaning proposed by Heller.

Enderlein (Sitzber. Gesell. Naturf. Freunde, Berlin, 1917, 309) proposed an outline classification covering the Kingdom of Mychota, or bacteria, which was based on comparative morphology with special emphasis on life

cycles. This was as follows:

Phylum I. Dimycksta Kreis A. Holacuclamornha

Class I. Ganascota Order a. Synascota

Family 1. Schaudinnidge

Genus a. Schaudinnum

b. Theciobactrum

Family 2. Spheerotilidae

Genus a. Phragmidiothrix

b. Newskia

c. Chlamudothrix

d. Sphaerotilus

e. Clonothrix Family 3. Syncrotidae

Genus a. Crenothrix

b. Beggiatoa

c. Suncrotis

d. Zugostasis

Family 4. Spirillidae

Genus a. Gallionella

b. Spirillum

c. Dicrospirillum

,

Family 5. Spirochaetidae

Genus a. Cristispira

b. Treponema

c. Entomospira

d. Spirochaeta

e. Cacospira

Family 6. Microspiridae Genus a. Spirobacillus

b. Spirosoma

c. Photobacterium

d. Micraspira

e. Dicrospira

Family 7. Cormobacteriidae

Subfamily 1. Actinomycinae

Genus a Actanomyces Subfamily 2. Eisenberginge

Genus a. Eisenbergia

Subjamily 3 Sclerotrichinge

Genus a. Zettnowia

b. Schlerathrix

Subfamily 4. Corunobacteriinae

Genus a. Carunobacterium

b. Heterocustia

e. Cladascus

d. Zygoplagia

Subfamily 5. Pseudostrepinae Genus a. Pseudostreptus

Order b. Ascota Family 8. Bacteriidae Genus a. Atremis

b. Bacterium

c. Lamprella

d. Eucystra
e. Dicrobactrum

f. Acystia
Family 9. Fusiformidae

Genus a. Fusiformis

Class II Sporascota

Order a Parasynascota
Family 10, Migulanidae
Genus a, Migulanum

Order b. Parascola

Family 11 Bacillidae Genus a. Rhagadascia

nns n. Rhagadascia b. Plectridium

e. Bacıllus

d. Bactrillum e. Kochella

f Fischerinum

Kreis B Hemicyclomorpha Class I. Anascola

Tamily 12 Hemallosidae
Genus a Hemallosis

Phylum II. Monomychola

Kreis A Acyclomorpha
Family 1. Mogallidae

Genus a. Mogallia Family 2 Sarcinidae

Genus a. Diplococcus

b. Sarcina

e. Paulosarcina Family 3. Micrococcidae

Genus a. Micrococcus

b. Planococcus
c Streptococcus

A Phacelium

Three of the new generic terms, Cladascus type species C. furcabilis Enderlein, Zygoplagia type species Z. alternans Enderlein and Helerocystia type species H. multiformus Enderlein, had been proposed in an earlier paper (Sitzber. Gesell. Naturf. Freunde, Berlin, 1916, 395). The following generic terms in the 1917 outline are new: Schaudinnum, Theciobactrum, Syncrotis, Zygostasis, Dicrospirillum, Entamospira, Cacospira, Dicrospira, Eisenbergia, Zeltnowia, Pseudostreplus, Alremis, Lamprella, Eucystia, Dicrostrepira, Acystia, Migulanum, Rhagadascia, Kockella, Fischerinum, Hemalbactrum, Acystia, Migulanum, Rhagadascia, Kockella, Fischerinum, Hemalbasis, Mogallia, Paulosarcina and Phacelium. Note that Corynobacterium is spelled with an o instead of an e.

Spenied with an o instead of an e.

Terms accepted from earlier workers that have not previously been

mentioned are: Spirobacillus Metschnikoff (Ann. Inst. Past., 3, 1889, 62), Photobacterium Beijerinek, Maanblad voor Natuurwetenschappen Amsterdam, 16, 1889, 1 and Arch. Neérl. d. Sci. Exactes, 23, 1889, 401), and Sclerothrix Metschnikoff (Arch. f. Path. Anat. u. Physiol., 113, 1888, 63-94; not Sclerothrix Kuetzing, Species Algarum, 1849, 319).

The above outline was changed in 1925, p. 235 ff. (Bakterien-Cyclogenic, Berlin, 390 pp.) by the addition of one new family, Chondromycidae, to include the genus Newskia, formerly included in Sphaerotilidae, and nine genera not previously given as follows: Chondromyces, Cystodesmia, Monocystia, Ophiocystia, Apelmocoena, Polyangium, Cystoecemia, Myzococcus and Dactylocoena. All except Chondromyces, Polyangium and Myzococcus are taken from Enderlein (Bemerkungen zur Systematik der Chondromyciden, Berlin, 1924, 6 pp.).

The new genus Lohnisium is added in the Family Eisenbergiinae to include the acetic acid and legume bacteria, and he also proposes the generic term Macrocystita (p. 278) for certain bacteria described by Peklo (O mšici krváve (Study of the blood louse). Zemědelského Archivu (Agricultural Archives), 1, 1916) from apliids. According to Enderlein it is not clear whether this genus should be included in the Family Bacteriidae or in Corunobacteriidae.

Two genera proposed by others are also accepted. These are Calymmatobacterium Aragão and Vianna (Mem. Inst. Oswaldo Cruz, 6, 1912, 211)
placed in the family Migulanidae, and Leuconostoc Van Tieghem placed in
the family Micrococcidae.

Later Enderlein (Sitzber. Gesell. Naturf. Freunde Berlin, 1930, 104-105) accepts Serratia Bizio in place of Dicrobactrum and Leplotrichia Trevisan in place of Syncrotis. Streptus with Streptus scarlatinae as type species, is proposed to cover the streptococci not included in Pseudostreptus.

The outline suggested by Pringsheim (Lotos, 71, 1923, 357) is similar to that used by Lehmann and Neumann (Atlas und Grundries der Bakteriologie, 2 vols, 1896, München). It is a conventional division into spherical, rod-shaped and curved forms so far as the true bacteria are concerned except that the pseudomonads are included in the same family as the vibrios and spirilla. Rhodobacteriales is recognized as an order to include the sulfur purple bacteria and the nonsulfur purple bacteria. Few details are given in regard to the other orders. His outline follows:

Schizomycetes
Order I. Eubacteriales
Family 1. Coccaceae
Genus a Streptococcus
b. Micrococcus
e. Sarcina

Family 2. Bacteriaceae Genus a. Baclerium b. Bacitlus Family 3 Spirillaceae Genus a Pseudomonas Vahrio h Spirillum Order II Rhadahacterrales Family 1 Rhodobacterinae 2 Thiorhodinae Order 111 Muzobacteriales Myxobacteriaccae Family 1 Order IV. Mycobacteriales Family 1 Cornnebacteriaceae 2. Mycobacteriaceae 3. Actinomycelaceae (Also possibly the long rod, lactic acid bacteria ) Order V Desmobacieriales

The first outline classification drawn up by Janke (Allgemeine Technische Mikrobiologie, I Teil, Dresden, 1924, p. 63) is an adaptation and expansion of that drawn up by Migula (System der Bakterien, 1900). The new genera recognized by Janke are Planostreptococcus A. Meyer (Die Zelle der Bakterien, Jena, 1912), Throploca Lauterborn (Ber. dtsch. Bot. Gesell., 25. 1907, 238), Thiobacterium Molisch (Cent. f. Bakt., Il Abt., 33, 1912, 55). Thiobacillus Beijerinck (Cent. f. Bakt , II Abt., 11, 1904, 593), Thiovibrio Janke (loc. cit.), Throspirillum Winogradsky (Beitrage zu Morphol. u. Physiol, d. Bakterien. Heft I. Schwefelbakterien. Leipzig, 1888), Thiosphaerella Nadson (Bull. Jar. bot Petersburg, 13, 1913, 106; ref. in Cent. f. Bakt., II Abt., 43, 1915, 469), Thiovulum Hintze (Ber. Dtsch. Bot. Gesell., 31, 1913, 189). Spirophyllum Ellis (Proc. Roy. Soc. Edinburgh, 27. I, 1907, 21; ref. in Cent. f. Bakt., II Abt., 19, 1907, 502), Nodofolium Ellis (Cent. f. Bakt , II Abt., 26, 1910, 321), and Actinococcus Beijerinek (Fol. Microbiol., 2, 1914, 185)

Family 1 Chlamydobacteriaceae Beomaloaceae

Janke's outline classification is given below:

Order 1. Lubacteria

Family 1. Coccaceae

Genus a. Streptococcus b. Micrococcus

- c. Sarcina

  - d. Planostreptococcus e Planococcus
  - f. Planosarcina

Family 2. Bacteriaceae

Genus a. Bacillus

b. Bacterium

Family 3. Spirillaceae

Genus a. Microspira

b. Spirillum

e. Spirosoma

Order II. Rhodobacteria

Family 1. Thiorhodaceae

Subfamily 1a. Thiocysteae Genus a. Thiocystia

h Thiocapsa

c. Thiosphaera

d. Thiosphaerion

e. Thiosarcina

Subfamily 2b. Lamprocysteae

Genus a. Lamprocystis

Subfamily 3c. Thiopedieae Genus a. Thiopedia

h. Thioderma

Subfamily 4d. Amoebobacterieae Genus a. Amoebobacter

b. Thiothece

c. Thiodictuon

d. Thiopolycoccus

Subfamily Se. Chromaticae Genus a. Chromatium

b. Rhabdochromatium

c. Thiorhodospirillum

Subfamily 6f. Rhodocapseae

Genus a. Rhodocapsa

b. Rhodothece

Family 2. Athiorhodaceae

Subfamily 1a Rhodocysteae Genus a. Rhodocustis

b. Rhodonostoc

c. Rhodococcus

d Rhodobacterium

e. Rhodobacillus

1. Rhodovibrio

g. Rhodospirillum

Order III. Thiobacteria

Family 1 Beggiatoaceae Genus a. Thiothrix

b. Beggiatoa

c. Thioploca

Family 2. Thiobacteriaceae

Genus a. Thiophysa

b. Thiobacterium

Thiobacillus d. Thiovibrio

e. Thiospirillum

Thiosphaerella

g. Thiovulum

b. Achromatium

Order IV. Phycobacleria

Genus a Leptothrix

b. Clonothrix

e Cladothrix

d Crenothrix

e. Phragmidiothrix

Appendix Genera Gallionella, Spirophyllum, Nodofolium Order V. Mycobacteria

Family 1. Mycobacteriaceae

Genus a Corynebacterium

h Mucobacterium

Family 2. Actinomycetaceae Genus a, Actinomices

b. Actinococcus

Order VI. Myxobacteria

Family 1. Myxobacterraceae

Genus a. Myzococcus

h. Chondromuces

c Polyanorum

Lehmann and Neumann (Bakt Diag., 2 vols , 7th ed , Munchen, 1926-27; Breed, Eng. trans., New York, 1931) developed their first simple and much used outline classification, drawn up in 1896, in later editions of their Determinative Bacteriology. The 1927 Lehmann and Neumann outline is as follows:

Class I. Schizomycetes

Order 1 Schizomycetales

Family 1. Coccaceae

Genus a Streptococcus

b. Sareina

c. Micrococcus

Sub-genus a Diplococcus

(Gram-positive group)

Family 2. Bacteriaceae Genus a. Bacterium

Sub-genus a Nitrosomonas

h Natrobacter

c. Rhizobium

d Haemophilus

e Brucella

f. Pasteurella

g (Glanders and dysentery group)

b. (Photogenic group)

(Aerogenes group)

j. Encapsulatus k. (Typhoid group)\*

Salmonella

m. (Coli group)

In a footnote under these groups, the authors refer to the names given by Castellani and Chalmers.

n. Acetobacterium

o. (Cloacae group)

p. (Red chromogens)

q. (Blue and violet ehromogens)

r. Pseudomonas

B. Proteus

App. Erysipelothrix Genus b. Fusobacterium

Jenus D. Puscoaci

c. Plocamobacterium

Family 3. Desmobacteriaceae

G nus a. Bengiatoa

b. Leptothriz

Sub-genus a. Leptothriz

b. Chlamydothrix

Genus c. Crenothrix

d. Cladothriz

e. Thiothrix

Family 4. Spirillaceae

Genus a. Vibrio

b. Spirillum

Family 5. Spirochaetaceae

Genus a. Spirochaeta

Family 6. Bacillaceae

Genus a. Bacillus

Sub-genus a. (Aerobic group)

b. (Anaerobic group)

Order II. Actinomycetales

Family 1. Proactinomycetaceae

Genus a. Corynebacterium

b. Mycobacterium

Family 2. Actinomycetaceae Genus a Actinomyces

The generic term Bacterium is retained in this outline to cover those groups of the true bacteria that are Gram-negative, non-spore-forming, motile and non-motile rods. Lehmann and Neumann recognize 20 subgroups in this genus, many of which correspond with the genera recognized in the Manual. In an effort to develop a rational nomenclature the term Acetobacterium (occurs first in review by Ludwig, Cent. f. Bakt., II Abt., 4, 1898, 870) is used in place of Acetobacter, Plocamobacterium (Loewi, Wienklin. Wehnschr., 83, 1920, 730) in place of Lactobactlus, and Fusobacterium (Knorr, Cent. f. Bakt., I Abt., Orig., 89, 1922, 4) in place of Fusiformis without regard to priority. Encapsulatus Castellani and Chalmers (Manual Tropical Med., 3rd ed., 1919, 934) is used in place of Klebsiella Trevisan (Atti Accad. Fis.-Med.-Stat. Milano. Ser. 4, 3, 1885, 107).

Janke (Cent. f. Bakt., II Abt., 66, 1926, 481) reprints the classification developed in the first edition of the present MANUAL and compares it with that proposed by Orla-Jensen and Enderlein.

The second complete outline drawn up by Janke (Oesterr, Bot, Zeitschr., 78. 1929. 108) is similar to the classification employed by Lehmann and Neumann (Bakt. Diag., 2 vols., 7th ed., Munchen, 1926-27). He follows Enderlein in placing Azotobacter in close association with the spore-forming rods. No new generic terms are suggested. His sub-groups of the genus Bacterium are even more closely similar to the genera used in the present edition of the Manual than are the sub-groups of Lehmann and Neumann.

Family 1. Coccaceae

Genus a. Macrococcus

b Neisseria c. Streptococcus

Divided into 4 groups.

d. Sarcina

Divided into 2 groups.

Family 2. Bacillaceae

Genus a. Bacillus

Divided into 16 groups

b. Azolobacter Family 3. Bacteriaceae

Genus a. Bacterium

Divided into 27 groups

b Fusiformis

Family 4. Corynobacteriaceae

Genus a. Mycobacterium

h Corunobacterium Actinomyces

Family 5. Spirillaceae

Genus a. Microspira Divided into 2 groups.

b. Spirillum

Divided into 2 groups.

Family 6. Spirochaetaceae Genus a. Spirochaeta

b. Borrelia c. Treponema

d. Cristispira

e. Saprospira

f. Leptospira

Family 7. Desmobacteriaceae

Genus a. Beggiatoa

b. Thioploca

c. Thiothriz d. Leptotrichia

e. Crenothriz

f. Sphacrotilus

g. Clenothriz h. Leptothriz

i. Phragmidiothriz

Family 8 Myzobacteriaceae
Genus a. Myzococcus
b. Palyangium
c. Chondromyces

Pribram (Jour. Baet., 18, 1929, 361) has rearranged some groups and combined others (e.g., Rhizobium, Diplococcus, Leuconostoc, Serratia, Flavobacterium, Chromobacterium, Achromobacter, Cellulomonas) recognized in the first edition of the Manual with little change in the nomenclature except among the anaerobic non-spore-forming rods and among the spore-forming rods. Unfortunately, he has sometimes used family and species names as generic names, thus in the latter ease introducing adjectives and adjectival terms as substantives. New generic terms suggested are: Dialisterea, Bacteroidea, Centrosporus, Fusibacillus, Pseudobacillus, Megatherium, Flexus, Anthrax, Botulinus, Chauvoca, Botulinea, Putrificus, Welchia, Phleobacterium, Distasoa, Tissieria, and Actinoidomyces. Astasia as it appears in this outline does not appear to be the same as Astasia Meyer (Flora, 34, 1897, 185). Aerobacillus is not synonymous with Aerobacillus Donker (Inaug. Diss., Delft, 1925). Sideromonas is accepted from Cholodny (Ber. Deutsch. Bot. Ges., 40, 1922, 326).

Pribram's complete outline follows:

Class Schizomycetes Subclass A. Protozoobacteria Order I. Spirochaetales Family 1. Spirochactaceae Genus a Spirochaeta b. Treponema c. Spironema Family 2. Cristispiraceae Genus a. Saprospira b Cristispira c. Leptospira Subclass B Eubacteria Order I. Protobacteriales Family 1. Natrobacteriaceae Related to Pseudomonas Tribe A. Hudrogenomonadae Genus a. Hudrogenomonas b. Methanomonas c. Carboxyodomonas Tribe B. Nutrobactereae Genus a. Nitrosomonas b Nitrobacter Family 2. Thiobacillaceae Tribe A. Thiobacilleac Genus a. Thiobacillus

Order II. Metabacteriales

Family 1. Pseudamonadaeeae

Tribe A. Spirilleae

Genus a. Spirillum Tribe B. Vibrioneae

Genus a. Vibrio

Tribe C. Pseudomonadene

Genus a Pseudomonos

b. Azotobacter

Connects with Palyangiaceae and Nitrobacteriaceae

Family 2. Bacteriaceae

Tribe A. Aerobactereae

Genus a. Aeralacter

b. Escherichia

c. Salmonella

d. Eberthella

e. Proteus Tribe B. Pasteurelleac

Genus a. Alcaligenes

b. Pasteurella

Connects with Pfeifferella

c. Hemaphilus

Connects with Dialister Family 3 Microcaecaceae

Tribe A. Streptucacceae Genus a. Neiszeria

b. Streptocaceus

Tribe B. Macrococcene

Genus a. Micracoccus b. Staphylacoccus

e. Sarcina

Connects with Algobacteria

Subclass C. Mycobacteria

Order I. Boctersomucetales

Pamily 1 Leptotrichaceoe

Tribe A. Acetabactereas Genus a. Acetobacter

Connects with Salmonella and Trasseria

Tribe B Leptotricheae

Genus a. Kurthia b. Lactobacillus

Connects with Corumebacterium

e. Leptotrichia

Connects with Erusinclothriz

Pamily 2. Bacteroidaceae

Tribe A. Dialistercae

Genus a. --- Type species Dialisterea cariecata Connects with Distason

ly ---- Type species Diglisterea cariabilis

c. Dialister

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Connects with Hemophilus
Tribe B. Bacteroideae
  Genus a. Type species Bacteroidea multiformis
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b. Bacteroides Connects with Tissieria

c. Type species Bacteroidea fusiformis

Order II. Bacillomucetales

Family 1. Bacillaceae

Sub-family 1a. Aerobacilloideae

Tribe A. Aerobacilleae

Sub-tribe A1. Centrosporineae

Genus a. Centrosporus h. Fusibacillus

Sub-tribe A2. Aerobacillineae

Genus a. Aerobacillus

Tribe B. Pseudobacilleae

Genus a. Pseudobacillus Sub-family 1b. Bacilloidene

Tribe A. Bacilleas

Sub-tribe Al. Bacillineae

Genus a. Bacillus

h. Megatherium Sub-tribe A2. Astasineae

Genus a. Astania

b. Flerus

Tribe B. Anthraceae Genus a. Anthrax

Family 2. Clostridiaceae

Sub-family 2a. Botulinoideae

Tribe A. Botulineae

Genus B. Botulinus b. Chauvoea

c. Type species Botulinea saccharolytica d. \_\_\_\_ Type species Botulinea butyrica

Tribe B. Putrificeae

Genus a. Putrificus

Sub-family 2b. Clostridioideae

Tribe A. Welchieae

Genus a. Welchia

Tribe B. Clostridicae Genus a. Clostridium

Order III. Actinomycetales

Family 1. Mucobacteriaceae

Tribe A. Actinobacilleae

Genus a. Pfcifferella Connects with Pasteurella

b. Actinobacillus

c. Corunebacterium

d. Erysipelothrix Connects with Leptotrichia Tribe B. Mucobaetereae

Genus a. Phleobacterium

b. Mycobacterium

Tribe G. Tissierieae Genus a. Distasoa

b. Tissieria

b. Tissieria

Connects with Bacteroides, Corynebacterium and Acetobacter Family 2. Actinomycelaceae

Tribe A. Actinoidomyeetaeeae

Genus a. Actinoidomyces Tribe B. Actinomycetoceae

Genus a. Actinomycetocea

Subclass D. Algobacteria

Order I. Desmobacteriales

Family 1. Sphaerotilaceae Genus a. Sphaerotilus

Order II. Siderobacteriales

Family 1. Chlamydotrichaeeae Tribe A. Chlamydotricheae

Genus a. Leptothriz b Crenothriz

Family 2. Siderocapsaceae

Genus a. Didymoheliz

b. Siderocapsa

c. Sideromonas

Order III. Thiobacteriales
Family 1. Rhodobacteriaceae
Sub-family 1a. Chromatoideoe

Sub-family 1a. Chromatoides Tribe A. Thioeapseae

Genus a. Thiocystis

b Thiosphaera

c. Thiosphaerion

d. Thiocapsa

e. Thiosarcina

f. Lamprocystis

Tribe B. Thiopedicae Genus a. Lampropedia

b. Thioderma

Tribe C. Amoebobacteriae Genus a. Amoebobacter

a. Amoebobacte
 b. Thiodictyon

c. Thiothece

d. Thiopolycoccus

Tribe D. Chromaticae

Genus a. Chromatium

b. Rhabdomonas

c. Thiospirillum

d. Rhodocapsa

e. Rhodothece

Sub-family 1b. Rhodobacteroideae Tribe A. Rhodobacteriaceae

Genus a. Rhodobacterium

b. Rhodobacillus

c. Rhodovibrio

d. Rhodospirillum

e. Rhodosphacra

Tribe B. Rhodocysteae Genus a. Rhodocustis

b. Rhodonostoc

Connects with Leuconostoc

Family 2 Beggiatoaceac

Genus a. Thiothrix b. Beggiatoa

c. Thioploca

Family 3. Achromatiqueae Genus a. Achrematium

b. Thiophysa

c. Thiospira

d. Hallhousia

Order IV. Myzobacteriales

Family 1. Polyangiaceae

Genus a. Chondromuces

b. Polyangium

Family 2. Muzococcaceae Genus a. Muxococcus

Later Pribram (Klassification der Schizomyceten (Bakterien), Leipzig and Wien, 1933, 143 pp.) developed this classification into a suggestive outline based on his experience in caring for the cultures of the Kral Collection. His most interesting contribution is the separation of the class of Schizomucetes into three subclasses which are based on differences in fundamental biological and nutritional relationships. The fourth sub-class of his earlier outline (the Protozoobacteria with its single order Spirochaetales) is omitted from this outline. The first class, Algobacteria, includes the bacteria that are primarily free living in water, usually motile with polar flagellation and live on easily soluble foodstuffs. They are frequently surrounded by insoluble secretions such as capsules, sheaths, etc., and form insoluble products in their protoplasm, such as ealcium, sulfur and iron compounds, and pigments. The class Eubacteria includes those bacteria whose normal habitat is the animal body or complex waste products of plant or animal origin. Because of adaptation to environment, these organisms are motile or non-motile and can utilize compounds of complex molecular structure. The third sub-class, Mucobacteria, is adapted to life in soil, and shows a distinct tendency to differentiation in morphology and spore formation.

Internationally accepted rules of nomenclature are generally followed, and the generic terms proposed in his earlier outline that were not formed

in accordance with recommended practices are discarded. He has revived Ulvina Kuttzing, 1837 (status explained by Buchanan, General Systematic Bacteriology, 1925, p. 518) in place of Actobacter Beijerinek and accepted Plocamobacterium (Loewi, Wien Kim. Webschr., 33, 1920, 730) in place of Lactobacillus Beijerinek, 1901. Among the spore-forming rods, he has accepted Bactrillum Fischer and Welchillus Heller, 1921. Malteomyces Hallier (Bot. Ztg., 24, 1866, 383) is used for the glanders bacillus. Anthractillus is apparently new.

The new outline has the following form:

Class Schizomycetes

Subclass A. Algobacteria

Family 1 Micrococcaceae

Genus a. Micrococcus

b. Rhodococcus

c. Rhodocopsa

d. Throcansa

e Thiosphoera

f. Throsphaerion

g. Thiocystis

h Lamprocystis

1 Sarcina

1 Throsorcina

Pamily 2 Pediococcaceae

Genus a Pediococcus

h. Lampropedia

e Thiothece

d Thiopolycoccus

a Thioderma

C Intouciate

f Amoebamonas

g. Rhodothecc h. Rhodonostoc

i. Thranhusa

Order 2 Pseudomonadales

Family 1. Pseudomonadaceae

Genus a. Pseudomonas

b. Rhodobacıllus

e. Chromatium

d. Nitrozomonas

e. Vibrio

f. Rhodovibrio

g. Myrococcus

h. Spirillum

i. Rhodospirillum

i. Thiospira

k. Thiospirillum Family 2. Serraliaceae

Genus a. Serratia

Family 3. Nitrobacteriaceae Genus a. Nitrobacter

b. Rhodobacterium

c. Rhodocystis

d. Didymoheliz
c. Sideromonas

. Staeromonas

f. Siderocapsa

g. Chondromyces

h. Polyangium

i. Amoebobacter

j. Thiodictyon

Family 4. Azotobaeteriaceae Genus a. Rhizobium

b. Azotobacter

Order 3. Leptotrichales

Family 1. Leptotrichaceae

Genus a. Leptothriz

b. Sphaerotilus

c. Crenothrix

Family 2. Clonothrichaceae Genus a. Clonothriz

Order 4. Rhabdomonadales

Family 1. Rhabdomonadaceae

Genus a. Beggiatoa

b. Rhabdomonas

c. Thioploca

d. Thiothriz

Family 2. Spirochaetaceae Genus a. Spirochaeta

b. Treponema

e. Leptospira

d. Cristispira

e. Saprospira

Subclass B. Eubacteria

Order 1 Aerobacteriales

Family 1. Aerobacteriaceue Genus a. Aerobacter

b. Escherichia

c. Salmonella

d. Eberthella

e. Shigella Family 2. Pasteurellaceae

Genus a. Pasteurella

b. Brucella

c. Haemophilus d Neisseria

Order 2. Plocamobacteriales

Family 1. Streptococcaceae Genus a. Streptococcus

Family 2. Ulvinaceae Genus a. Proteus

b. Kurthia

- Ulning
- d. Plocamobacterium
- e. Lentotrichia

Family 3. Bacteron daceae

Genus a. Dialister

b. Aerobacteroides

c. Barteroides

d. Fusobacterium

Subclass C. Mucobacteria

Order 1. Bacillales

Family 1. Bacillaceae

Genus a. Bactrillum

b. Aerobacillus

c. Barillus

d. Anthracillus

Family 2. Clostridiaceae

Genus a. Clostridium

b. Welchillus

Order 2. Mycobacteriales

Family 1. Mycobacteriaceae

Genus a Malleomuces

b Actinobacillus

c. Corynebacterium

d. Erysipelothriz

e. Mycobacterium

1. Distance

g. Titaieria

Family 2 Actinomycetaceae Genus a. Actinomycoides

b Actinomuces

Janke (Cent. f. Bakt., II Abt., 80, 1930, 481) reprints the earlier outline prepared by Pribram (1929) and, after commenting on Lehmann and Neumann's (1927) outline, proposes an outline which is slightly modified from his own previous (1929) outline. Two new subgeneric terms are used. Angerobacillus and Eubacterium The sub-genus Acrobacillus is apparently not the same as Acrobacillus Donker (Inaug. Diss., Delft, 1926), nor as Aerobacillus Pribram (Jour. Bact., 18, 1929, 361).

Family I. Micrococcaceae

Genus 1. Micrococcus

Divided into 2 sections.

2 Neisseria 3. Streptococcus

Divided into 4 sections.

4. Sarcina

Divided into 2 sections.

Family II. Bacillaceae Genus 1. Bacilius

> Sub-genus a. Anaerolacillus or better Clostridium Divided into 6 sections.

b. Aerobacillus or better Eubacillus
Divided into 10 sections

Family III. Bacteriaceae Genus 1. Bacterium

Sub-genus a Pseudomonas

Divided into 6 sections.

b. Eubaeterium

Divided into 11 sections.

Trichobacterium

Divided into 6 sections.

Genus 2. Fusiformis

Family IV. Corynobacteriaceae Genus 1. Mucobacterium

2. Pfeifferella

3. Erusinelothrix

4. Corunobacterium

4. Corynobacterius
5. Actinomyccs

Family V. Spirillaceae

Genus 1. Microspira or Vibrio

Sub-genus a. Microspira b. Spirosoma

Genus 2. Spirillum Sub-genus a, Spirella

nus a. Spirciia b. Dicrospirillum

Family VI. Sprochaetaccae

Genus 1. Spirochaeta

2. Cacospira

3. Entomospira

4. Treponema 5. Cristispira

5. Cristispira

0. Saprospira
7. Leptospira

Family VII Desmobacteriaceae

As in 1929 outline.

Family VIII. Myxobacteriaceae
As in 1929 outline.

Kluyver and Van Niel (Cent. f. Bakt., II Aht., 94, 1936, 369) have developed an outline classification in which they indicate four lines of development from the simplest form of cell that is existent and conceivable, the sphere. They assign family rank to each of these four groups of hacteria, placing the lophotrichous (and related non-motile) rod-shaped hacteria (if (Pseudomandaceae). This is followed by the family of spherical hacteria (Micrococcaceae) and the family of permanently non-motile, rod-shaped hacteria (Algobacteriaceae). The final family includes the peritrichous (and related non-motile) rod-shaped bacteria, the Bacteriaceae. These are grouped in the tribes of each family in accordance with their fundamental metaholism as photo-autotrophic, photo-heterotrophic, chemo-autotrophic and chemo-heterotrophic. Their outline follows:

#### Family A. Pseudomonadaceae

1. Tribe Spirillege

#### Genus 1. Thiospirillum

- Phaeospirillum. 2 3. Rhodospirillum
- 4. Sulfospirillum
- 5. Spirillum

#### II. Tribe Vibrianege

### Genus 1. Chromatium

- 2. Rhodovibrio
- 3. Didymoheliz
- 4. Vabrio

### 5. Desulfovibrio

#### III Tribe Pseudomonadeae Genus 1. Thiotheco

#### 2. Phacomonas

- 3. Rhodonzonas
- 4. Sulfomonas
- 5 Sideromonas
- 6 Natrosomonas
- 7. Nitrobæcter
- 8. Acetobaeter
- 9. Pseudomonas
- 10. Rheedbeum
- 11. Azotobacter 12. Listerella
- 13. Aeromonas
- 14 Zymomonas

#### 15 Methanobaclerrum

#### Family B. Micrococcaceae

#### IV. Tribe Micrococceae

#### Genus 1. Chlorobium

- 2 Throvolucoccus
- 3 Rhodococcus
- 4. Achromatium
- 5. Siderocapsa
- 6. Natrozococcus
- 7 Neisseria
- 8. Microcorcus
- Yerlionella
  - 10 Peptococcus
  - Methanococcus 11

### V Tribe Sarcinege

#### Genus 1. Therredia

- 2. Thioearcing 3. Gaffkya
- 4. Sarcina
- 5. Zymosarcina
- 6. Bulvrisorcina
- 7. Methanospreina

VI. Tribe Sporesarcineae

Genus 1. Sporosarcina

VII. Tribe Streptococceae Genus 1. Pentostreptococcus

2. Streptococcus

3. Betacoccus Family C. Mycobacteriaecae

VIII. Tribe Corynebactericae

Genus 1. Cormebacterium

2. Fusiformis

3. Propionibacterium

4. Streptobacterium

5. Betabacterium

IX. Tribe Mycobactericae

Genus 1. Mycobacterium

2. Thermolacterium

Family D. Backeriaceae X. Tribe Bactericae

Genus 1. Kurthia

2. Alcalinenes

3. Bacterium

4. Acrobacter

X1. Tribe Bacilleae

Genus 1. Bacillus

2. Aerobacillus

3. Zymobacillus

4. Clostridium

5. Peptoclostridium

Some old names are displaced by new descriptive terms: Phacospirillum Sulfospirillum, Desulforibrio, Phaeomonas, Acromonas, Zymomonas, Methanobacterium, Methanococcus, Methanosarcina, Butyrisarcina, Peptococcus, Pertostreptococcus, Zumobacillus. Rhodomonas is not used in the same sense as Rhodomonas Orla-Jensen (Cent. f. Bakt., 11 Abt., 22, 1909, 331 and 334). the latter being a synonym of Chromatium Perty (Zur Kenntniss kleinster Lebensformen, 1852). Sulfomonas is indicated as new and as a synonym of Thiobacillus Beijerinck (Cent. f. Bakt., II Abt., 11, 1904, 598) although the same term is used by Orla-Jensen (loc. cit.). Three new terms are accepted: Chlorobium Nadson (Bull. Jard. Bot. St. Petersburg, 6, 1906, 184), Zymosarcina Smit (Die Garungssarcinen, Jena, 1930) and Peptoclostridium (Donker, Inaug. Diss., Delft, 1926).

Rahn (Cent. f. Bakt., II Abt., 96, 1937, 273) has reviewed the characters of the species of Eubacteriales included in the fourth edition of this MANUAL. He places 146 of the spore-forming species in a Sub-order A. Endosporales with a single family, and 536 of the species of non-spore-forming rods in a Sub-order B. Asporales in seven families. Unclassifiable species (total 224) are placed in a temporary eighth family Bacteriaceae. His outline follows: Order Eubacteriales

Suborder A. Endosporales

Family I. Endosporaceae

Genus 1. Bacillus

2. Aerobacillus

2. Aerobacillus 3. Clastridium

Suborder B. Asporales

Family I. Gramozidaceae

Genus 1 Micrococcus (including Staphylococcus, Gaffkya, Rhodococcus and most of the species of Sarcina)

2. Kurthia

Family II. Gramanoxidaceae

Tribe a Streptococceae

Genus 1. Streptococcus (including Diplococcus)

2. Leuconostoc

3 Peptostreptococcus

Tribe b Lactobacillea e

Genus 4 Lactobacillus (including part of Bucteroides)

5 Propionibacterium

Tribe c. Sarcineae

Genus 6. Zymosarcina

7. Butyrizarcina

8 Methanosarcina

Family III. Neissereaceae Genus 1. Neisseria

2 Veillonella
Family IV. Protobacteriaceae

Tribe a. Protobacterieae

Genus I Carboxydomonas

2. Methanomonas

Tribe b. Nutrobacterieae

Genus 1. Nitrosomonas

2 Netrobaeter
3. Netrosococcus

Family V. Enterobacterraceae

Genus 1. Enterobacter (including Escherichia, Salmonella, Aerobacter, Klebsiella, Proteus,

Erwinia, Eberthella, Shigella, and parts of Serratia, Preudomonas, Flavobacterium and Achromobacter)

Family VI. Pseudomonada ceae

Genus 1. Pseudomorius (includes Phytomonas and other lophotrichous types only)

2. Vibrio

3. Spirillum

4. Acetobacter
5. Azotobacter

6. Rhizobium

Family VII. Parvobacteriaceae

Genus 1. Brucella

2. Pasteurella

3. Hemophitus (including Dialister)

Family VIII. Bacteriaceae

Unclassifiable genera including Alcaligenes and Protaminobacter; some species from each of the following genera, Achromobacter, Chromobacterium, Cellulomonas, Bacteroides, Flasobacterium, Phytomonas, Pseudomonas, Serraita; and three species from the Family Nitrobacteriaceae.

One of the generic terms used in this outline is new, i.e., Enterobacter. Two other generic terms, Fluorescens and Erythrobacterium, are proposed incidentally (p. 284). The first includes the peritrichous forms included in the Manual under Pseudomonas and the second includes those red, non-spore-forming rods that are not included in Serratia. In another footnote (p. 281) a substitute, Virgula, is suggested for Enterobacter. Emphasis is placed on sporulation, Gram stain, and oxygen demand as the most important characters aside from cell form and flagellation.

Prévot, as an outgrowth of his studies on anaerobes with Weinberg (Weinberg, Nativelle and Prévot, Les microbes anaérobies, 1937, 1186 pp., Paris), has written a series of papers in which he has developed a classification of anaerobic bacteria (Ann. Sei. Nat., 10 Sér., 15, 1933, 23-260; Ann. Inst. Past., 60, 1938, 285-307; 61, 1938, 72-91; 64, 1940, 117-125). The conclusions reached in these studies are summarized in his Manual de Classification et de Détermination des Bactéries Anaérobies, Monographie de l'Institut Pasteur, Paris, 1940, 223 pp. He regards the bacteria as comprising a kingdom, Schizomycetes, intermediate hetween the animal and plant kingdoms and notes the presence of strict anaerohes in at least three of the seven orders recognized in the 5th edition of the Manual. These orders be regards as classes. The genus Bacteroides Castellani and Chalmers (Manual of Trop. Med., 3rd ed., 1919, 959) type species, Bacteroides fragilis, is dropped (Ann. Inst. Past., 60, 1938, 288), and several new terms are proposed for the organisms included by Castellani and Chalmers and later investigators in the genus Among the new generic names is Ristella which is hased on Ristella fragilis, the species used by Castellani and Chalmers as the type species for Bacteroides.

The complete outline classification developed by Prévot in bis Monograph (loc. cit., p. 17) is given below:

Kingdom. Schizomyceles Nägeli Class I. Eubacteriales

Sub-Class I. Non sporogenous Eubacteriales

Order I. Micrococcales

Family I. Neisstriaceae

Tribe I Neisseriege Genus a Neisseria

Tribe 2 Veillonelleae Genus a Veillonella

Family 2 Micrococcaceas

Tribe I Streptococceae Genus a Diplococcus

b Streptococcus

Tribe 2 Staphylococceae

Genus n. Gaffkia b. Staphylococcus

Tribe 3 Micrococceae

Genus a Sarcina

b Micrococcus

Order II. Bacteriales
Family 1 Ristellaceae

Genus a Ristella

b Pasteurella

d. Zuberella

e. Capsularie

Family 2. Bacteriaceae Genus a Lubacterium

us a Eubacterrum h Catenadocterium

e. Ramibacterium

d Cillobacterium

Order III. Sperillales
Family 1 Vibrionaceae

Genus a. Vibrio
Sub-class II Sporogenous Eubacteriales

Order I Clostridiales
Family 1 Endosporaceae

Genus a Endosporus

b Paraplectrum

Family 2 Clostridiaceae Genus a Infiabilis

b. Welchia

e Clastridium

Order II Picciridiales
Family I Terminosporaceae

Genus a Terminosporus

Family 2 Pleetridiaceae

Genus a. Plectridium b · Acuformis

Order III. Sporovibrionales Family 1. Sporovibrionaceae

Genus a Sporovibrio

Class II. Actinomycetales

Family 1. Spherophoraceae

Genus a. Spherophorus

b. Spherocillus
 c. Fusiformis

d. Fusocillus

e. Leptotrichia

Family 2. Actinomycelaceae Genus a. Actinobacterium

b. Bifidibacterium

c. Corunebacterium

Class III. Spirochetales
Family 1. Spirochaelaceae

Genus a. Treponema

b. Borrelia

In this outline, there are minor modifications in the names and in endings given to the orders and tribes as compared with those given in his preliminary papers. In the Order Micrococcales, Leuconostoc has been dropped as a genus of the tribe Streptococceae and Rhodococcus has been dropped as a genus of the Tribe Staphylococccae. Veillonella proposed by Prévot as a new genus in 1933 (loc. cit., p. 70) is included as a genus in the Family Neisseriaceae. The spelling of Gaffkya is changed to Gaffkia. In the first of Prévot's papers published in 1938 (loc. cit.), he proposes the following new genera in the Order Bacteriales; Ristella, Zuberella, Capsularis. Eubacterium, Catenabacterium, Ramibacterium and Cillobacterium. In the same paper he also proposes the following new genera in the Order Actinomycetales: Spherophorus, Spherocillus, Fusocillus, Pseudoleptothrix (withdrawn in 1940 in favor of Leptotrichia Trevisan). He also accepts one genus Actinobacterium (Hans, Cent. f. Bakt., I Abt., Orig., 40, 1906, 180) not previously mentioned in this discussion. With the single change noted (Pseudoleptothrix to Lepototrichia), the outlines of the genera in the orders Bacteriales and Actinomycetales remains in the 1940 outline as it was given in 1938.

In the outline given in Prévot's Monograph (loc. cit., p. 17) one change is made in the generic terms recognized in the Order Clostridiales from those recognized in his second paper published in 1938. The genus name Palmula proposed in 1938, having been found to be invalid because of prior use for a genus of Protozoa, is changed to Acufornis. Other generic names which appeared for the first time in the 1938 outline are Endosporus, Inflabilis, Terminosporus and Caduceus. Welchia proposed by Prévot in 1933 (loc. cit., p. 44) was previously proposed by Pribram (Jour. Bact., 18, 1929, 374) for the same group of anaerobic spore-forming rods. A third order, Sporoubrionales, is proposed by Prévot in his Monograph (loc. cit., p. 15) to include the family Sporoubrionaceae (Ann. Inst. Past., 64, 1940,

119). This order and family include a single genus Sporovibrio Starkey (Arch. f. Microb., 9, 1938, 300) syn. Desulfovibrio Kluyver and Van Niel (Ccnt. f. Bakt., II Abt., 94, 1936, 389). Two genera (Treponema and Rorrelia) of Spirochactales are listed by Prévot in his Monograph (loc.cut., p. 16) as including anaerobic species.

Stanier and Van Nicl (Jour. Bact., 42, 1941, 437-466) have proposed a rearrangement of the classification outline as indicated below:

Kingdom Monera Muzophyla (Blue-green algae) Division I Division II Schizomucetae (Bacteria) Class I Eubacteriae Order I Rhodobacteriales Order II Eubacteriales Order III Actinomycetales Class II Myxobacteriae Muzobacteriales Order I Class III Spirochaetae Order I Spirochaetales Appendix to Division Schizomycctae Group I Includes two families, Leptotrichaceae and Crenothricaceae Achromatraceae Group II

Group III Pasteuriaceae (Includes three genera, Pasteuria, Hyphomicrobium and Blastocaulis)

The genera Mycobacterium, Corynebacterium, Erysipelothrix, Leptotrichia, Nevskia, Gallionella, Caulobacter, Thiospira, Siderocapsa and Sideromonas are placed in Eubacteriales. Two genera not previously discussed in this review whose relationships to other bacteria have recently been clarified are Sporocytophaga Stanier (Jour. Bact., 40, 1940, 629) and Cytophaga Winogradsky (Ann Inst. Past., 43, 1929, 578).

This rearrangement has been carried out by including the organisms placed in the Order Caulobacteriales Henric and Johnson (Jour. Bact., 30, 1935, 61-93) in the Order Eubacteriales Henric and Johnson (Jour. Bact., 8, 1917, 162). The genera of the Order Chlamydobacteriales Buchanan (loc cit.) are transferred to an appendix or are dropped (Clonothriz) as belonging to the blue-green algae. Three of the remaining five orders are raised to the rank of classes, one of which (Eubacteriae) includes three orders Rhodobacteriales (Pringsheim, Lotos, 71, 1923, 351), Eubacteriales (Buchanan, loc. cit.) and Actinomycetales (Buchanan, loc. cit.) are the sulfur purple, the non-sulfur purple and the green bacteria, the colorless sulfur bacteria (Begriatoaceae) heing transferred to the Myzophyła with the change of the name of the Order from Thiobacteriales Buchanan (loc. cit.) to Rhodobacteriales Pringsheim (loc. cit.).

The cutting classification below is proposed by the Editorial Board of the Maxim for use in the present (6th) edition of the Maxim. It is based on those developed by Bergey et al. in earlier editions. These, in turn, were based on the outline classifications developed by Buchanan (Jour, Ract., 1, 1916, 591; 6, 1917, 185 ff.; 8, 1918, 27 ff.) and Winslow et al. (Jour, Ract., 3, 1920, 191).

Phylum Solierwhita
Class II. Schumphiceae
Class II. Schumphiceae
Class II. Schumphiceae
Chas II. Schumphiceae
Order I. Enhanteralite
Sub-Order II. Enhanteriliteae (includes Comprehentriaceae)
Sub-Order III. Enhanteriliteae (includes Comprehentriaceae)
Sub-Order III. Enhanteriliteae
Order III. Methodoxideriliteae
Individual Champholociteriales
Family I. Contobrichaeeae
Family II. Engintereae
Ampendix Achampholocite
Ampendix Achampholocite
Ampendix Achampholocite
Ampendix Achampholocite
III. Begintereae

Order IV. Myzobacteriales
Order V. Surochaetales

Supplement: Groups whose relationships are uncertain.

Group I Order Richensiales, Group II, Order Virales, Group III, Family Borrelomacetacore.

In this, the arrangement of Schizomycetes as a class coordinate with Schizophyceae, both belonging to a phylum Schizophyda of the plant kingdom, is maintained as before. The number of orders is reduced from seven as given in the fifth edition of the Manual to five, through recognition of the fact that the rigid, uniceflular, sometimes branching but never truly mycefial nor filamentous organisms belonging to three of the previously recognized orders are presumably more closely related to each other than they are to the organisms in the four remaining orders. The family Coryme-bacteriaceae has been transferred from the order Actinomycetales to Eubacteriales.

The colorless, filamentous, sulfur bacteria (Beggiatanceae) have been placed in the order Chlamydobacteriales with the other filamentous bacteria that are clearly related to the blue-green algae. While this marks the greatest deviation from the outline previously used, and separates these colorless sulfur bacteria from the purple sulfur bacteria placed in Rhodobacterineae, it is in accordance with the arrangement accepted by Lehmann and Neumann (Bakt. Diag., 4 Aufl., 2, 1907, 598), Pringsheim (Loter, 71, 1923, 307) and others. Rhodobacterineae is also limited to the purple and green bacteria as suggested by Pringsheim (Loc. cit.) and accepted by Kluyver and Van Niel (loc. cit.), by Stanier and Van Niel (loc. cit.) and others.

The Rickettsiales and Borrelomycetaceae are placed in a supplement as their relationships are still obscure. Several authors would place them near some of the organisms now placed in Pasteurella and Haemophilus. The viruses (Virales) whose nature and relationships are still more obscure are also placed in a supplemental group.

Although this outline maintains the simplicity that distinguished its predecessors, and provides places for all types of microorganisms thus far described that may properly be grouped under the fission fungi, it should not be regarded in any sense as final. An attempt has been made to express natural relationships, but these are so frequently obscure or unknown that in many places utilitarian considerations have prevailed. In some places, groups of known doubtful significance have been allowed to stand as they are out of a desire not to make unnecessary changes. It has appeared desirable to be conservative in making changes in the outline as used previously.

Addenda: After the above was in page proof, it was discovered that reference to the outline classification of Gieszezykiewicz (Bull. Adad. Polonaise d. Sci. et d. Lettres, Cl Sci. Math. et Nat., Sér. B., 1939, 27 pp.) had inadvertently been omitted. This outline has some features like the outline that Lehmann and Neumann used in 1927 (see p. 17) and some like the outline used in the 4th ed. of the Manual.

The genus Bacterium is retained as in the Lehmann and Neumann outline for Gram-negative, non-spore-forming, peritrichous or polar flagellate rods. Twelve sub-genera are recognized and these bear subgeneric scientific names that are much the same as those used for genera in the 4th ed, of the Manual. A new subgeneric name Enterobacterium (see Enterobacter Rahn) is proposed to cover the genera Escherichia, Aerobacters (Rebesiella, Salmonella, Eberthella and Shigella. Loefflerella proviously such by Gay et al. (Agents of Disease and Heat Resistance, Indianapolis, 1935, 782) is here also used as a subgeneric name for the glanders bacillus; and Chromobacterium is used for the organisms more properly placed in Serratia Bizio.

Corynebacterium is transferred from the order Actinomycetales to Lubacteriales and the family Corynebacteriacea is made to include Lactobacillus, Erysipelothrix and Fusobacterium. Among the Spirochactales, the genus name Spirochacta is displaced by a new generic term, Ehrenbergia, and is itself used to displace Borrelia.

A seventh order Richettsiales is proposed to include two families: Richettsiaceae with one genus Richettsia da Rocha Lina (Berl, klin, Welmschr., 1916, 567); and Bartonellaceae with the genera, Bartonella Strong, Tyrzer, Brues, Sellards and Gastiaburü (Jour. Amer. Med. Assoc., 61, 1913, 1713), and Grahamella Brumpt (Buil Soc. Path Exot. 4, 1911, 514).

During 1945, Soriano (Cieneia e Investigación, 1, 1945, 92-91 and 146-147; Rev. Argentina de Agronomia, 12, 1945, 120) proposed an arrangement of the Class Schizomycetes in which he recognizes a new Order, Flexibacteriales, to include the 'families Cytophagaceae and Beggiatoaceae and an entirely new Family Flexibacteriaceae containing a single genus Flexibacter. The latter includes five newly recognized species of flexuous bacteria as follows: Flexibacter flexilts, type species, F. elegans, F. giganteus, F. albuminosus and F. aureus.

The outline given below shows how this new order and new family are fitted by Soriano into the classification used in the fifth edition of the MANUAL.

#### Class Schizomycetes

Subclass Eubacteriae. Rigid cells.
Order I. Eubacteriales
Order II. Caulobacteriales
Order III. Rhodobacteriales
Order IV. Actinomycetales
Order V. Chlamydobacteriales
Order VI. Myzobacteriales
Order VII. Myzobacteriales
Order VIII. Myzobacteriales
Order VIII Spirochactets

Prévot (Ann Inst. Past. 72, 1946, 1) has developed his elassification of Class Actinomycctales, subdividing it into orders and including several genera not recognized in his 1940 outline. This classification is as follows:

#### Class Actinomucetales

New order Not acid-fast Order I Actinobacteriales Family I Spherophoraceae Family II. Actinomycelaceae. Genus I Spherophorus Genus I Actinomyces Genus II Haverhillia Genus II Proactinomuces Genus III Spherocellus Genus III Corynebacterium Genus IV Actinobacterium Genus IV Fusiformis Genus V Fusocillus Genus V Bifidibacterium Genus VI Leptotrichia Genus VI. Erysipelothrix Order II Mucobacteriales New order Acid-fast

Genus I Mucobacterium

This classification differs from that used in this edition of the Manual in that it places several genera of Gram-negative organisms in Actinomy-cetales These are Spherophorus, Haverhillia, Spherocillus, Fusiformis and Fusocillus, all of which are included here under Parobacteriacae. Leptotrichia which Prévot regards as Gram-negative is generally accepted as being a Gram-positive group. It is discussed in this edition of the Manual in connection with the genus Lactobacillus.

#### HOW BACTERIA ARE NAMED AND IDENTIFIED\*

Some principles of taxonomy and nomenclature. "Taxonomy is that branch of biology that deals with the orderly arrangement of plants and animals" (Johnson, Taxonomy of the Flowering Plants, New York, 1931, p. 3).

The necessity for applying names to species or kinds of bacteria is selfevident. It is highly desirable that the name applied to an organism by one person should be understood by others. It is further desirable that as far as practicable all individuals use the same name for the same kind of organism. It is belpful, therefore, if there can be an agreement regarding the method of naming organisms, and as to the correct name for each organism. The term nomenclature is applied to the naming of plants and animals, and under this term may be included all discussions as to methods of naming and correctness of particular names.

It is not enough that bacteria be named. Some method of classification of the bacteria is essential if the names are to be rendered accessible and available, and identification of unknown forms be made possible. Taxonomy is that branch of biology which treats of classification in accordance with a convention or law. It is apparent that taxonomy must be dependent in part for its satisfactory development upon nomenclature. Even though there may not be agreement among bacteriologists as to the exact classification that is to be used, nevertheless it is highly desirable that there be agreement as to some of the fundamental characteristics of satisfactory biological classifications in general

What kinds of names are used. Two kinds of names are commonly given to the different kinds of plants and animals, the common, provincial. vernacular or casual names on the one hand and the international or seientific names on the other. These should be carefully differentiated, and their respective advantages and disadvantages noted.

It is inevitable, and on the whole probably desirable, that for each kind of familiar animal or plant in each language there will be coined a name. Usually the name for the same organism will be different in each language. For example, we have in English Oak, in German Liche, in Latin Quercus. etc. For many uncommon kinds, however, there may be no such vernaenlar names developed. There have been, of course, many casual or vernacular names given to kinds of bacteria. In English we speak of the tuberele bacillus, the typhoid germ, the gonococcus, the Welch bacillus, the golden

<sup>\*</sup> Contributed by Prof R. E. Buchanan, Iowa State College, Ames, Iowa, January, 1931; revised, March, 1913.

pus coceus, and many others. Similarly, we find in German Typhus-bazillen and in French bacille typhique, enterococcus, etc. The use of these common names offers certain advantages. It does away frequently with the necessity of repeating longer and more formal scientific names. Not infrequently scientific names may be adopted into a language, and converted into vernacular names. For example, the English name aster and the scientific generic name Aster are applied to the same group. This is frequently a coavenience, but there are also some difficulties, which will be emphasized below.

In contrast to common, vernacular or casual names, the scientific name for each kind of organism (each plant or animal) is supposed to be the same in all countries and in all languages. When such a scientific name is used, no question should arise in any language as to what organism is intended. The names thus applied are supposed to conform to certain general rules that bave been formulated by international agreement. Obviously the use of such names is advantageous whenever one is desirous of accuracy, and of being definitely understood in all languages. It is further evident that in all questions relating to taxonomy and classification it is highly desirable that the scientific names be used.

International rules for nomenclature. In order that there he an international set of scientific names, it is essential that there be an international agreement as to the rules which should govern their creation. Both of the great groups of biologists, the botanists and the zoologists, have met in numerous international eongresses in which delegates were necredited by the great botanical and zoological societies, museums, and educational institutions of the world. Codes of nomenclature designed to tell how names shall be manufactured and used, and how to tell which of two or more names that have been used is correct, have been developed by each of these groups. These codes or lists of rules and recommendations are quite similar in essentials for hotany and zoology, although they differ in some details.

The question arises: Are either or both of these codes satisfactory or adaptable to the use of bacteriologists. Three views have been expressed by various writers. Some few have suggested that the naming of bacteria cannot well conform to the approved international rules as their classification involves considerations not familiar to botanists and zoologists generally. The second group, also a very small one, has insisted that unicellular forms of life are neither plants or animals, but profista, and that taxonomic rules, etc., should be distinct for this group and coördinate with the corresponding rules for plants and for animals.

The third view, more commonly expressed, is that the bacteria are sufficiently closely related to the plants and animals, so that (in so far as they apply) the international agreements of the botanists (or zoologists) should be used as a basis for naming them.

International opinion on this topic was finally crystallized by resolutions adopted by the First International Congress of the International Society for Microbiology held in Paris in 1930 and by the Fifth International Botanical Congress held in Cambridge, England in the same year.

The resolutions unanimously adopted by the plenary session of the

International Society for Microbiology were in part as follows:

"It is clearly recognized that the living forms with which the microbiologists concern themselves are in part plants, in part animals, and in part primitive. It is further recognized that in so far as they may be applicable and appropriate the nomenclatural codes agreed upon by International Congresses of Botany and Zoology should be followed in the naming of micro-organisms. Bearing in mind, however, the peculiarly independent course of development that bacteriology has taken in the past fifty years, and the elaboration of special descriptive criteria which bacteriologists have of necessity developed, it is the opinion of the International Society for Microbiology that the bacteria constitute a group for which special arrangements are necessary. Therefore the International Society for Microbiology has decided to consider the subject of bacterial nomenclature as a part of its permanent program."

The International Society of Microbiologists established a permanent Nomenclature Committee to pass upon suggestions and to make recommendations. This committee is composed of members from all participating nations. Two scoretaries were named, one (Dr. St. John-Brooks of the Lister Institute, London, England) to represent primarily medical and vectoriaary bacteriology, and one (Dr. R. S. Breed, New York State Agricultural Experiment Station, Geneva, New York, U. S. A.) to represent

other phases of bacteriology.

The cooperation of the International Botanical Congress was solicited in the naming of this committee. The resolutions were approved by the Section on Bacteriology of the Botanical Congress and the Congress itself incorporated into the Botanical Code certain special provisions relating to the bacteria. It also specifically recognized the International Committee as the body to prepare recommendations relating to bacterial nomenclature.

It is apparent, therefore, that there has been international agreement (in so far as this can be achieved) that bacteriologists should follow the botanical or zoological codes in the naming of bacteria to the extent they are applicable, and that exceptions or new problems should be presented

to the International Committee.

These rules are so important in determining the validity of bacterial names that the rules of the Botanical Code are included in somewhat

abridged form in the section that follows this introduction. Any student who has occasion to name a new species or a new genus or determine the validity of a name should familiarize himself with these rules and recommendations.

An effort has been made in the present volume to use nomenclature in conformity with these rules.

Some general principles of nomenclature. Every student of bacteriology should be familiar with certain rules of nomenclature if he is to use names intelligently. If he wishes to correct names improperly used or if he desires to name new species, there are additional rules which he must observe.

- 1. Each distinct kind of bacterium is called a species.
- 2. To each distinct species a name is given consisting usually of two Latin words, as Bacillus subtiles.
- 3. The first word is the name of the genus or group to which the organism belongs. It is always written with a capital letter. It is a Latin or Greek word, or a new word compounded from Latin or Greek roots, or it may be derived from some other language; but this is important, whatever its origin when used as a generic name it must be regarded and treated as a Latin noun. If it is a word not found in classic Latin, it is regarded as modern Latin.' Some generic names in bacteriology which are Latin or formed from Latin roots are Bacillus (masculine) a small rod: Cristispira (feminine) a crested spiral: Lactobacillus (masculine) a milk small rod: Sarcina (feminine) a packet or bundle. Many others are words from the Greek or compounded from Greek roots, with the words transliterated into Latin letters and endings in conformity with Latin usage; words of Greek origin are Micrococcus (masculine) a small grain (sphere); Bacterium (neuter) a small rod, Clostridium (neuter) a small spindle; Corynebacterium (neuter) clubbed small rod; Actinomyces (masculine) ray fungus. Other generic names have been given in honor of persons or places as Beggiatoa (feminine). Borrelia (feminine), Eberthella (feminine), Pasteurella (feminine), Erwinia (feminine), Zophus (masculine).
- The second word in the scientific name is a specific epithet. It is not capitalized except that certain authors capitalize species names derived from proper nouns.

It may be:

(a) An adjective modifying the noun, and indicating by its ending agreement with the generic name in gender, as Bacterium album (white Bacterium), Bacillus albus (white Bacillus), Sarcina alba (white Sarcina), Eberthella dispar (the different Eberthella), Bacterium variable (the variable Bacterium), Brucella melitensis (the maltess Brucella), Bacillus teres (the rounded Bacillus), Bacillus gravelens (sweet-smelling Bacillus).

Mesculine albus niger tener acer variabilis dispar coccordes	Typical adjectives Feminine alba nigra tenera acris variabilis dispar coccoides	Neuter album negrum tenerum acre variabile dispor coccoides
aerogenes	coccoides aerogenes	coccoides

(b) An adjective in the form of the present participle of a verb, as Clostridium dissolvens (the dissolving Clostridium, in the sense of the Clostridium which is able to dissolve), Bacillus adharens (the adhering Bacillus), Acetobacter ascendens (the climbing Acetobacter), Bacillus esterificans (the ester-producing Bacillus). The endings for present participles used as adjectives are the same for all genders. The past participle is used occasionally, as in Pseudomonas aptata (the adapted Pseudomonas), Spirillum attenuatum (the attenuated Spirillum).

(c) A noun in the genitive (possessive) modifying the generic name. There is no necessary agreement in gender or number. Examples, Clostridium welchii (Welch's Clostridium), Salmonella pullorium (the Salmonella of chicks), Streptococcus latits (the Streptococcus of milk), Brucella abortus (the Brucella of abortion), Clostridium tetani (the Clostridium of tetanus), Diplococcus pneumonias (the Diplococcus of pneumonia), Salmonella anatum (the Salmonella of ducks)

(d) A noun in apposition, that is, an explanatory noun. This does not agree necessarily with the generic name in gender. This method of naming is relatively not common in bacteriology. Examples are Actinomyces scalies (the scurf or seah Actinomyces), Bacillus lacticola (the milk-dweller bacillus), Bacillus radictola (the root-dweller bacillus).

5. The author of the name is often indicated following the name of the species, as Bacillus subitlis Cohn. Sometimes a name is indicated also in parenthesis, as Micrococcus luteus (Schroeter) Cohn. This means that Schroeter first named the species, giving it the name luteus, but placed it in another genus (Bacteriatum). Cohn placed it in a new genus. It should be noted that the name of a person, following the name of an organism is frequently not the person who first discovered or described it, but the person who first gave it the name used. For example, Clostridium vetchii (Migula) Holland was first described by Dr. Wm. II. Welch, but not named by him. It was named by Migula in honor of Dr. Welch and later it was placed in the genus Clostridium by Holland.

 Sometimes species of bacteria are subdivided into varieties. These are likewise given Latin designations, and the entire name written as: Streptococcus lactis var. maltigenes (the Streptococcus of milk producing malt flavor).

Some principles of taxonomy. It is important further that the student of bacteriology recognize the meaning of certain terms used regularly in classifications.

(1) Species (plural species). A species of plant (or animal) is assumed above to be one kind of plant. But how much difference must exist between two cultures of bacteria before one is justified in regarding the organisms in them as being of distinct kinds or species? No rule can be laid down. It depends largely upon convenience and n more or less arbitrary decision. As stated by Hitchcock (Descriptive Systematic Botany, New York, 1925, p. 8): "The unit of elassification is a coherent group of like individuals, called a species. The term is difficult to define with precision because a species is not a definite entity, but a taxonomic concept." Hucker and Pederson (New York Agric, Exper. Stn. Tech. Bull. 167, 1930, p. 39) state: "The difficulty met with among these lower forms in dividing them into well-defined groups has led many to question whether these small groups or 'species' are natural groups and whether such groups can be considered to be similar to 'species' among higher forms. However this may be, it is necessary to arrange bacteria as well as possible into groups or so-called 'species' for convenience in classification," and again (Hucker, New York Agric, Exper. Sta. Tech. Bull. 100, 1921, 29), "characters applicable to the differentiation of species must evidence a certain amount of constancy when studied over a large series of tests. Furthermore, characters adapted to the differentiation of larger natural groups or genera should, in addition to constancy, show some correlation with other constant characteristics. The presence of this relationship or correlation between characters for the division of genera indicates that the groupings are being made along natural rather than artificial lines."

Type culture. It is quite evident that when a new species of bacterium is described, it must include the particular culture from which the species description was made. This original culture is termed the type culture. We may develop a definition as follows:—A species of bacterium is the type culture or specimen together with all other cultures or specimens regarded by an investigator as sufficiently like the type (or sufficiently closely related to it) to be grouped with it. It is self-evident that different investigators may not draw the same boundaries for a given species. This leads to some practical difficulties, but no better definition bas been evolved.

There are certain special cases which require brief discussion.

(a) How should one designate the different stages in an organism that exhibits a growth cycle? There seems to be increasing evidence that certain bacteria show cycles in morphology which parallel to some degree those well

known among the fungi. Such, for example, may well be the rough (R) and smooth (S) types described for many bacteria, possibly the filterable stages noted by many authors, the so-called G types, etc. It is evident that an adequate description of any species of bacterium should include a description of each of these stages in the cyclical development wherever such is proved to exist. In all other cases in botany and in zoology which involve growth stages or cycles one stage has been chosen and designated as the mature or adult or perfect stage. In ferns, for example, names and classifications are based largely upon the sporophytic generation, in insects upon the adult or imago, in the rusts upon the stage in which the teleutospores are produced. There has been no international agreement as to what stage should be thus designated for the bacteria. Beyond doubt, it would be the stage which is most easily cultured and studied in the laboratory, the stage with which we are best acquainted in the laboratory. It might easily happen in bacteria (as it has with fungi) that two different stages of the life cycle of single species have been described and named as separate species. When the mistake has been discovered, the name given to the mature or perfect stage is the one that is accepted. In general the descriptions given in the present volume are those which may be regarded as belonging to the perfect stage. Unfortunately it is not yet possible accurately to group the stages in many of the bacteria that have definite growth cycles.

It is desirable frequently to designate the stage with which one is working. This may be done by some conventional symbol, as S (smooth type), G

(filterable stage), etc.

(b) How should one designate variants which differ in some minor respects from the type, but which do not constitute growth stages? For example, the species Bacillus subtilis normally produces endospores. Suppose that an asporogenous race is derived from such, agreeing with the parent culture in all respects, but showing no tendency to revert to spore production. What such an organism should be called is a matter of judgment. It might frequently be designated as an asporogenous strain, or more technically if one desires as a variety. It might be termed, for example, Bacillus subtilis var. asporus. In other cases such expressions as Diplococcus pneumoniae Type I, or the Rawlings strain of the typhoid bacillus may be used.

Unfortunately there is no general agreement upon the exact significance which the word "strain" should have in bacteriology. It is recommended that it refer merely to source, e g. the Rawlings strain of Eberthella typhoza, and that it be never used to connote a biological character. This would not prevent such expressions as "a non-motile strain of Salmonella suipeslifer", but it would make erroneous a statement to the effect that the A

strain of influenza virus differs from the B strain in certain ways. In other words, "strain" is not a synonym of "type" or "variety". We may have as many yellow strains of the typboid bacillus as we have of cultures of it, from different sources or specimens.

(2) Genus (plural genera). A genus is a group of related species. In some cases a genus may include only a single species (is said to be manotypic) in most cases several to many species are included in a genus. The question asked above may be paraphrased. How close must be the resemblances (how close the relationships) among the species of a group to entitle them to inclusion in the same genus? In other words, how is it possible to delimit accurately the boundaries of a genus? This is a matter on which there is no agreement, and probably can be none. Much of the confusion in modern bacteriological terminology is to be attributed to this fact. Nevertheless, in course of time experience tends to delimit many generawith reasonable accuracy. As stated by Hitchcock (Descriptive Systematic Botany, New York, 1925, p. 9): "Convenience may play a rôle in determining generic lines. Extremely large groups may be broken up on the basis of differences of smaller degree not common to a group of closely allied species, than if the group consisted of a few species. In general, the botanist, in delimiting genera, keeps in mind two important requirements, that of showing natural affinities and that of aiding correct identification." However, a genus may be defined helpfully in another way. One of the species described as belonging to a genus is designated as the type species. A genus may be defined then, as including this type species together with such other species as the investigator (or taxonomist) regards as sufficiently closely related. It is apparent that some authors may draw the lines narrowly, others broadly. Some authors, for example, recognize only two genera of rod-shaped bacteria, one for those without endospores (Bacterium), and one for those producing endospores (Bacillus). These genera thus defined are very large, each containing hundreds, perhaps thousands, of species. Other students break up these large genera into many smaller ones. There is not much point to the question as to which is right and which is wrong. A better question is, which is the more convenient, better represents relationships, better facilitates diagnosis and proves most useful. As organisms become hetter known, it may be possible through the agency of the International Committee on Nomenclature to reach agreements where lack of agreement leads to serious confusion or misunderstanding.

(3) Family. A family in taxonomy is a group of related genera. In general the name of the family is made from the name or former name of one of their genera by affixing the suffix -accae to the root. The word is regarded as plural. Among baeterial families commonly recognized are Bacillaceae. Bacteriaccae. Micraoccaeae. Spirachactaceae, Actinomycetaccae.

- (4) Order. An order is a group of related families. It is named usually (not always) by substituting the suffix -ales for -accae in the name of the type family. Among ordinal names that have been used in bacteriology are Actinomycetales. Spriochaetales. Eubacteriales.
- (5) Class. A class is a group of related orders. In this treatise it is considered that the bacteria constitute a class of the plant kingdom, and this is named Schizomycetes.
- (6) Other categories. Other categories or ranks of pames are used for higher groups. Sometimes families are divided into sub-families, these into tribes, these into subtribes, and these finally into genera.

How to identify an organism by name. One of the maio purposes of a manual of determinative bacteriology is to facilitate the finding of the correct scientific name of a bacterium. Such is the purpose of this volume. It is well, however, to note some of the reasons why this result, the identification of an unknown culture, may not eventuate. Among these reasons the following may be listed:

- (1) The unknown organism awaiting identification by the investigator may easily be one which has never been named, or perhaps adequately described. For the most part there has been little effort on the part of bacteriologists to describe or name bacteria except as they have been found to have some economic significance or possess some striking or unusual characteristics. It is quite probable that there are many times as many species of bacteria undescribed and named as have been described. Such undescribed species are all about us. It is not surprising, therefore, if one frequently encounters undescribed species. When such unamed species are encountered, particularly if they are of economic importance or are related to such forms, it is highly desirable that they should be described, named and the results published and made accessible.
- (2) The unknown organism may have been described and named in some publication, but the description and name have been over-looked in the preparation of the Manual. Perhaps the description has been so inadequate or incomplete that it has not been possible to place it in the classification. It should be noted that the number of species that have been described is so great that no one individual can know them all. Progress in classification comes about largely as the result of the work of specialists in particular groups. For example, Ford made a study of all of the aerobic spore-bearing bacteria which he had secured from various sources. He studied also the descriptions of such bacteria in the literature, and then monographed the group. Similar studies on other groups have resulted in more or less complete monographs. Such, for example, are the monographs on the intestinal group by Welden and Levine, of the acetic bacteria by Hoyer, and Vieser 't Hooft, of the cocci by Hucker, of the

pathogenic spore-bearing anacrobes by the English Commission, by Weinberg, and by others, of the red, rod-shaped bacteria by Hefferan and by Breed, of the actinomycetes by Waksman and by Lieske, of the root nodule bacteria of legumes by Fred and his co-workers, etc. Unfortunately most groups of bacteria have not thus been monographed. It is evidently the function of a manual such as this to draw largely upon the work of the monographers, and to supplement their achievements as far as possible by less satisfactory consideration of the unmonographed groups.

It is clear that because an organism cannot be identified from this text is not proof that it has not been described and named. The species most closely related may be determined, then the literature searched carefully for species described still more closely related or perhaps one identical.

(3) It is possible, of course, that nn error has been made in the selection of the correct name. It is desirable that users of these keys and descriptions should be familiar with the rules governing the correct choice of names, and make suitable corrections where needed.

Steps in determining the name of an organism. The steps in the identification of an unknown organism are usually the following:

- (1) Preparation of an adequate description of the organism.
- (2) Knowledge of construction and use of keys.
- (3) Determination of order, family and genus by use of key.

Preparation of description of organism. Before attempting to determine the name of an "unknown" organism an adequate description is essential. Just what characteristics must be emphasized depends upon the group in which the organism falls. It is desirable that the knowledge of the characters of the unknown be as complete as possible.

Use and construction of keys. An exceptionally clear and satisfactory discussion of the making and use of keys and symopose is given by Hitchcock (Descriptive Systematic Botany, New York, 1925, p. 101). Anyone planning to monograph a group is advised to read this. He states: "A key is an orderly arrangement of a series of contrasting or directly comparable statements, by which groups of the same category may be distinguished and indicated or identified," and "A key is primarily a mechanical device by which one may arrive at the name of the ultimate member of the group." In general the keys used in this Manual are dichotomous, that is, the successive divisions are in twos, differentiation being into two contrasted groups.

Determination of order, family and genus by use of keys. The method of doing this is discussed in the introduction beginning on page 1.

#### RULES OF NOMENCLATURE\*

In Paris in 1930, the First International Microbiological Congress voted to follow the rules of nomenclature agreed upon by International Congresses of Botany and Zoology "in so for as they may be applicable and appropriate." The adoption of the date of the publication of Species Plantarum by Linnaeus in 1753 as the point of departure for hacteriological nomenclature was recommended. This recommendation was approved by the plenary session of the Microbiological Congress (Proc. 1" Cong. Internat. Microbiol., Paris, 1930, 2, 1932, 519) and by the plenary session of the Botanical Congress (Rept. Proc. 5th Internat Bot. Cong., 1930, Cambridge, 1931, p. 16 and 23).

This Congress also provided for the organization of an International Committee on Bacteriological Nomenclature with two permanent secretaries:

 To represent primarily medical and veterinary hacteriology,—Dr. R. St. John-Brooks, Lister Institute, London, England

 To represent primarily other phases of hacteriology,—Dr. R. S. Breed, Experiment Station, Geneva, New York, U. S. A.

During the years that have elapsed since its appointment, this Committee has organized and has taken various actions in the interest of a more stable nomenclature and classification. Some of these have heen completed and accepted by the Second International Congress of Microhiology held in London, 1936. These completed actions are quoted below, and are incorporated into the classification used in the descriptive portion of the Manual.

The International Rules of Botanical Nomenclature were originally adopted by the International Botanical Congresses of Vienna (1903) and Brussels (1910). They were modified by the Cambridge Congress (1930) so as to accept the type method, and validate species descriptions of bacteria unaccompanied by a Latin diagnosis. Some further but less important modifications were made at the Amsterdam Congress (1935) (See Sprague, Science, 83, 1936, 416).

The following are the most important of the rules that are of interest to bacteriologists taken from the latest available edition of the Botanical Code (Gustav Fischer, Jena, 1935). Sections that were newly adopted or amended by the Amsterdam Botanical Congress (1935) are indicated in the text.

<sup>\*</sup> Contributed by Prof. R. S. Breed, New York, State Experiment Station, Geneva, New York, September, 1938; revised, October, 1943.

#### INTERNATIONAL RULES OF BOTANICAL NOMENCLATURE, 1930–1935

#### Chapter I. General Considerations and Guiding Principles (Art. 1-9)

Art. 1. Botany cannot make satisfactory progress without a precise system of nomenclature, which is used by the great majority of botanists in all countries.

Art. 2. The precepts on which this precise system of botanical nomenclature is based are divided into principles, rules, and recommendations. The principles (Art. 1-9, 10-14 15-19) form the basis of the rules and recommendations. The object of the rules (Art. 19-74) is to put the nomenclature of the past into order and to provide for that of the future. They are always retroective; names or forms of nomenclature contrary to a rule (illegitimate names or forms) cannot be maintained. The recommendations deal with subsidiary points, their object being to bring about greater uniformity and clearness in future nomenclature; names or forms contrary to a recommendation cannot on that account be rejected, but they are not examples to be followed.

Art. 3 The rules of nomenclature should be simple and founded on considerations sufficiently clear and forcible for everyone to comprehend and be disposed to accept.

Art. 4. The essential points in nomenclature ara: (1) to aim at fixity of names; (2) to avoid or to reject the use of forms and names which may cause error or ambiguity or throw scenee into confusion.

Next in importance is the avoidance of all useless ereation of names.

Other considerations, such as absolute grammatical correctness, regularity or cuphony of names, more or less prevailing custom, regard for persons, etc., notwithstanding their undeniable importance, are relatively accessory.

Art. 5. In the absence of a relevant rule, or where the consequences of rules are

doubtful, established custom must be followed,

Art. 7. Scientific names of all groups are usually taken from Latin or Greek.
When taken from any language other than Latin, or formed in an arbitrary manner,
they are treated as if they were Latin. Latin terminations should be used so far as
possible for new names.

Art. 8. Nomenclature deals with: (1) the terms which denote the rank of taxonomic groups (Art. 10-14), (2) the names which are applied to the individual groups

(Art. 15-72).

Art. 9. The rules and recommendations of botanical nomenclature apply to all groups of the plant kingdom, recent and fossil, with certain distinctly specified exceptions.

#### Chapter II. Calegories of Taxonomic Groups, and the Terms Denoting Them (Art. 10-14, Rec. I, II)

Art. 10. Every individual plant belongs to a species (species), every species to a genus (genus), every genus to n family (familia), every family to an order (orda) every order to a class (classis), every class to a division (diviso).

### Chapter III. Names of Tazonomic Groups (Art. 15-72, Rec. III-L)

Section 1. General Principles: Priority (Art. 15-17, Rec. III)

Art. 15. The purpose of giving a name to a taxonomic group is not to indicate the characters or the history of the group, but to supply n means of referring to it.

Art. 16. Each group with a given circumscription, position, and rank can bear only one valid name, the emiliest that is in accordance with the Rules of Nomenclature.

#### Section 2. The Type Method (Art. 18, Rec. IV-VII)

Art 18. The application of names of taxonomic groups is determined by means of iomenclatural types. A nomenclatural type is that constituent element of a group o which the name of the group is permanently attached, whether as an accepted name or as a synonym. The name of a group must be changed if the type of that name is racluded (see Art. 66).

#### Section 3. Limitation of the Principle of Priority: Publication, Starting-points, Conservation of Names (Art. 19-22)

Art. 19. A name of a taxonomic group has no status under the Rules, and has no claim to recognition by botanists, unless it is validly published (see Art. 37).

Art. 20. Legitimate botanical nomenclature begins for the different groups of plants at the following dates:

(h) Myzomycetes, 1753 (Linnaeus, Species Plantarum, ed. 1).\*

Art. 21. However, to avoid disadvantageous changes in the nomenclature of genera by the attict application of the Rules of Nomenclature, and especially of the principle of priority in starting from the dates given in Art. 20, the Rules provide a list of names which must be retained as exceptions. These names are by preference those which have come into general use in the fifty years following their publication, or which have been used in monographs and important floristic works up to the year 1890.

# Section 4. Nomenclature of the Tazonomic Groups According to Their Categories (Art 23-35, Rec. VII-XX)

1. Names of Groups above the Rank of Family,

Rec. IX. Orders are designated preferably by the name of one of their principal families with the ending -ales.

2 Names of Families and Subfamilies, Tribes, and Sub-tribes.

Art. 23. Names of families are taken from the name or former name of one of their genera and and in -accae.

Art. 24. Names of subfamilies (subfamilias) are taken from the name of one of the

RAIL 24. Names of submines (wa) antices are taken from the name of one of the genera in the group, with the ending -oideae, similarly for tribes (tribus), with the ending -rae, and for subtribes (subtribus) with the ending -raes.

3. Names of Genera and Subdivisions of Genera.

Art. 25. Names of genera are substantives (or adjectives used as substantives), in the singular number and written with an initial capital, which may be compared with our family names. These names may be taken from any source whatever, and may even be composed in an absolutely arbitrary manner.

Recommendation X. Botanists who are forming generic names show judgment and taste by attending to the following recommendations.

(a) Not to make names long or difficult to pronounce.

(b) Not to deducate genera to persons quite unconnected with botany or at least with natural science, nor to persons quite unknown.

(c) Not to take names from barbarous languages, unless those names are frequently cited in books of travel, and have an agreesble form that is readily adaptable to the Latin tongue and to the tongues of civilized countries.

<sup>\*</sup> See page 48 for action on date for Schizomycetes.

- (d) To indicate, if possible, by the formation or ending of the name the affinities or analogies of the genus
- (e) To avoid adjectives used as nouns.
- (f) Not to give a genus a name whose form is rather that of a subgenus or section (e.g. Euradrarylon, a name given to a genus of Lauraceae. This, however, being legitimate, cannot be altered).
- (g) Not to make names by combining words from different languages (nomina hybrida).
- 4. Names of Species (binary names).

Art. 27. Names of species are binary combinations consisting of the name of the genus followed by a single specific epithet. If an epithet consists of two or more words, these must either be united into one or joined by a hyphen. Symbols forming part of specific epithets proposed by Linaceus must be transcribed.

The specific epithet, when adjectival in form and not used as a substantive, agrees with the generic names.

Recommendations.

XIII. The specific epithet should, in general, give some indication of the appearance, the characters, the origin, the history or the properties of the species. If taken from the name of a person it usually recalls the name of the one who discovered or described it, or was in some way concerned with it.

XIV Names of men and women, and also of countries and localities used as specific epithets, may be substantives in the genitive (Clusia, scharce) or adjectives (Clusianus, dahuricus) It will be well, in the future, to avoid the use of the genitive and the adjectival form of the same epithet to designate two different species of the same genus e.g. Lysimachia Hemsleyana Maximum. (1891), and L. Herisleyi Franch. (1895).

- XV. In forming specific epithets botanists will do well to have regard also to the following recommendations:
  - (a) To avoid those which are very long and difficult to pronounce.
  - (b) To avoid those which express a character common to all, or nearly all, the species of a genus.
  - (c) To avoid using the names of little-known or very restricted localities, unless the species is quite local.
  - (d) To avoid, in the same genus, epithets which are very much alike, especially those which differ only in their last letters
  - (e) Not to adopt unpublished names found in travellers' notes or in herbaria,
  - attributing them to their authors, unless these have approved publication.

    (f) Not to name a species after a person who has neither discovered, nor described, nor figured, nor in any way studied it.
  - (g) To avoid epithets which have been used before in any closely-allied genus.
  - (h) To avoid specific epithets formed of two or more (hyphened) words,
  - To avoid epithets which have the same meaning as the generic name (pleonasm).

#### Section 5. Conditions of Effective Publication (Art. 36)

Art. 36. Publication is effected, under these Rules, either by sale or distribution of printed matter or indelible autographs to the general public, or to specified representative botanical institutions.

No other kind of publication is accepted as effective: communication of new names at a public meeting, or the placing of names in collections or gardens open to the public, does not constitute effective publication.

#### Section 6. Conditions and Dates of Valid Publication of Names (Art. 37-45, Rec. XXI-XXIX)

- Art. 37. A name of a taxonomic group is ant validly published unless it is both (1) effectively published (see Art. 36), and (2) accompanied by a description of the group or by a reference to a previously and effectively published description of it.
- Art 38. From January I, 1935, names of new groups of recent plants, the Bacteria excepted, are considered as validly published only when they are accompanied by a Latin diagnosis.
- Art. 40. A name of a taxonomic group is not validly published when it is merely cited as a synonym.
- Art. 42. A name of a genus is not validly published unless it is accompanied (1) by a description of the genus, or (2) by the citation of a previously and effectively published description of the genus under another name, or (3) by a reference to a previously and effectively published description of the genus as a subgenus, section or other subdivision of a genus
- Art. 43. The name of a monotypic new genus based on a new species is validated (1) by the provision of a combined generic and specific description, (2) by the provision of a plate with analyses showing essential characters, but this applies only to plates and generic names published before January I, 1908.
- Art. 44. The name of a species or of a subdivision of a species is not validly published unless it is accompanied (1) by a description of the group, or (2) by the citation of a previously and effectively published description of the group under another name, or (3) by a plate or figure with analyses showing essential characters, but this applies only to plate or figures published before January 1, 1908
- Art. 45. The date of a name or of an epithet is that of its valid publication (see Art 19, 38). For purposes of priority, however, only legitimate names and epithets published in legitimate combinations are taken into consideration (see Art 60). In the absence of proof to the contrary, the date given in the work containing the name or erithet must be regarded as correct.

Botanists will do well in publishing to conform to the following recommendations:

XXI. Not to publish a new name without clearly indicating whether it is the name of a family or a tribe, a genus or a section, a species or a variety, briefly, without expressing an opinion as to the rank of the group to which the name is given.

Not to publish the name of a new group without indicating its type (see Recommendation IV).

XXII. To avoid publishing or mentioning in their publications unpublished names which they do not accept, especially if the persons responsible for these names have not formally authorized their publication (see Recommendation XY (e.g.).

XXVI. To give the etymology of new generic names and also of new epithets when the meaning of these is not obvious

XXVII. To indicate precisely the date of publication of their works and that of the placing on sale or the distribution of named and numbered plants a hen these are accompanied by printed diagnoses. In the case of a work appearing in parts, the last published sheet of the volume should indicate the precise dates at which the different fascicles or parts of the volumes were published as well as the number of pages in each.

XXVIII. When works are published in periodicals, to require the publisher to indicate on the separate copies the date (year and month) of publication and also the title of the periodical from which the work is extracted

XXIX. Separate copies should always bear the pagination of the periodical of which they form a part; if desired they may also bear a special pagination.

#### Section 7. Citotion of Authors' Nomes for Purposes of Precision (Art. 46-49, Rec. XXX-XXXII)

Art. 46. For the indication of the name (unitary, binary, or ternary) of a group to be accurate and complete, and in order that the date may be readily verified it is necessary to cite the author who first published the name in question.

Art. 47. An alteration of the diagnostic characters or of the circumscription of a group does not warrant the citation of an author other than the one who first pub-

lished its name.

When the changes have been considerable, an indication of their nature and of the author responsible for the change is added, the words mutotic charact, or pro porte, or excl. gen, excl. sp, excl. sp, excl. sp, some other abridged indication being employed.

Art. 48. When a name of a taxonomic group has been proposed but not published hy one author, and is subsequently validly published and ascribed to him (or her) by another author who supplied the description, the name of the latter author must be appended to the citation with the connecting word "ez."

If it is desirable or necessary to abbreviate such a citation, the name of the publish-

ing author, being the more important, must be retained.

When a name and description by one author are published by another author, the word opud is used to connect the names of the two authors, except where the name of the second author forms part of the title of a book or periodical in which case the connecting word in is used instead.

Art. 49. When a genus or a group of lower rank is altered in rank but retains its name or epithet, the original author must be cited in parenthesis, followed by the name of the author who effected the alteration. The same holds when a subdivision of a genus, a species, or a group of lower rank is transferred to another genus or species with or without alteration of rank.

## Section 8. Retention of Nomes or Epithets of Groups which are Remodelled or Divided (Art. 50-52)

Art. 50. An alteration of the diagnostic characters, or of the circumscription of a group, does not warrant a change in its name, except in so far as this may be necessitated (1) by transference of the group (Art. 53-55), or (2) by its union with another group of the same rank (Art. 56-57), or (3) by a change of its rank (Art. 58-57).

Art. 51. When a genus is divided into two or more genera, the generic name must be retained for one of them, or (if it has not been retained) must be re-established. When a particular species was originally designated as the type, the generic name must be retained for the genus including that species. When no type was designated, a type must be chosen according to the regulations which will be given (Appendix I).\*

Art. 52. When a species is divided into two or more species, the specific epithet must be retained for one of them, or (if it has not been retained) must be re-established. When a particular specimen was originally designated as the type, the specific epithet must be retained for the species including that specimen. When no type was designated, a type must be chosen according to the regulations to be given (Appendix I).

Appendix I has not been published as yet. See Type Basis Code, p. 61.

Section 9. Retention of Names or Epithets of Groups Below the Rank of Genus on Transference to Another Genus or Species (Art, 53-65)

Art. 63. When a subdivision of a genus is transferred to another genus (or placed under another generic name for the same genus) without change of rank, its subdivisional name must be retained, or (it it has not been retained) must be re-established unless one of the following obstacles custs: (1) that the resulting association of names has been previously published waldly for a different subdivision, or (2) that there is available an earlier validly published sub-divisional name of the same rank

Art. 54. When a species is transferred to another genus (or placed under another generic name for the same genus), without change of rank, the specific epithet must be retained or (it it has not been retained) must be re-established, unless one of the following obstacles exists (1) that the resulting binary name has been previously and validly published for a different species, (2) that there is available an earlier validly published specific entitlet.

"When, on transference to another genus, the specific cpithet has been applied erroneously in its new position to a different plant, the new combination must be retained for the plant on which the epithet was originally based, and must be attributed to the author who first published it " (Accepted in this revised form at the Ameteriam Botauleal Congress, 1935)

Art, 55 When a variety or other subdivision of a species is transferred, without change of rank, to another genus or species (or placed under another generic or specific name for the same genus or species), the original subdivisional epithet must be retained or (if it has not been retained) must be re-established, unless one of the following obstacles evists: (i) that the resulting ternary combination has been previously and validly published for a subdivision based on a different type, even if that subdivision is of a different rank; (2) that there is an earlier validly published subdivision lepthet available.

When the epithet of a subdivision of a species, on transference to another species, has been applied erroneously in its new position to a different plant, the epithet must be retained for the plant on which the group was organially based.

Example. The variety micronihum Gren & Godf (Fl France, 1, 171 1847) of Helinathemic stalicum Pers, when transferred as a variety to H penicillatum Thit, retains its varietal critics, becoming H penicillatum var micronihum (Gren. & Godf.) Grosser (in Figs), Phantemerch, Helt 14, 115 1793)

# Section 10 Choice of Names when Two Groups of the Same Rank are United, or in Fungs with a Pleomorphic Life-cycle (Art. 52, 57, Re. XXXIII-XXXV)

Art. 56. When two or more groups of the same rank are united, the oldest legitimate name or (in species and their subdivisions) the oldest legitimate cyribet is retained. If the names or explicits are of the same date, the author who united be groups has the right of choosing one of them. The author who first adopts one of them, definitely treating another as a synonym or referring it to a subordinate group, must be followed.

Art. 57. Among Fungi with a pleomorphic life-cycle the different successive states of the same species (anamorphoise, status) can bear only one generic and specific name (binary), that is the extities which has been given, statuing from Fries, Systema, or Fries, Systema, or Fries, Synopsis, to the state containing the form which it has been agreed to call the perfect state is that which ends in the assess stage in the Assonycette, Bules. The perfect state is that which ends in the assess stage in the Assonycette,

in the basidium, in the Basidiamycetes, in the teleutospore or its equivalent in the Uredinales, and in the spore in the Uredinales.

Generic and specific names given to other states have only a temporary value. They cannot replace a generic name already existing and applying to one or more species, any one of which contains the "perfect" form

The nomenclature of Fungi which have not a pleomorphic life-cycle follows the ordinary rules.

#### Section 11. Choice of Names when the Rank of a Group is Changed

Art. 58. When a tribe becomes a family, when a subgenus or section becomes a secules, or when the reverse of these changes takes place, and in general when a group changes its rank, the earliest legitimate epithet given to the group in its new rank is valid, unless that name or the resulting association or combination is a later homonym (see Art. 60, 61).

# Section 12. Rejection of Names (Art. 59-69, Rec. XXXVII)

- Art. 50. A name or epithet must not be rejected, changed, or modified merely because it is badly chosen, or disagreeable, or because another is preferable or better known (see also Art. 69).
- Art. 60. A name must be rejected if it is illegitimate (see Art. 2) The publication of an epithet in an illegitimate combination must not be taken into consideration for purposes of priority, "except as indicated in Art. 61." (Added at the Amsterdam Botanical Congress, 1935.)
  - A name is illegitimate in the following cases:
- (1) If it was superfluous when published, i.e., if there was a valid name (see Art. 16) for the group to which it was applied, with its particular circumscription, position and rank.
- (2) If it is a hinary or ternary name published in contravention of Art. 16, 50, 52, or 54, Lo., if its author did not adopt the earliest legitimate epithet available for the group with its particular erieumserpition, postion, and rank
  - (3) If it is a later homonym (see Art. 61) (except as regards Art. 54 and 55).
  - (4) If it is a generic name which must be rejected under Art. 67.
  - (5) If its specific epithet must be rejected under Art. 63.
- Art. %1. A name of a tavonomic group is illegitimate and must be rejected if it is a later homonym, that is, if it duplicates a name previously and validly published for a group of the same rank based on a different type. Even if the earlier homonym is illegitimate, or is generally treated as a synonym on tavonomic grounds, the later homonym must be rejected. "When an author simultaneously publishes the same new name for more than one group, the first author who adopts one of them, or substitutes another name for one of them, must be followed." (Added at the Amsterdam Botanical Congress, 1935.)
- Art. 62 A name of a taxonomic group must be rejected if, owing to its use with a name of a taxonomic group must be rejected if, owing to its use with names to be abundoned for this reason (Nomina ambigua) will form Appendix IV.\*
- Art. 63. A name of a taxonomic group must be rejected when its application is uncertain (Nomen dubum): e g. Errum soloniems I. (Cent. II. Pl. 28:1756) is a name the application of which is uncertain; it must, therefore, be rejected (see Schinz and Thell in Vertelohrssehr. Nat Ges. Zürich. vin. 71 1913).

<sup>\*</sup> Appendix IV has not been published as yet.

Art. 61. A name of a taxonomic group must be rejected if the characters of that group were derived from two or more entirely discordant elements, especially if those elements were erroneously supposed to form part of the same individual

A list of names to be abandoned for this reason (Noming confusa) will form Appendix VI.\*

Art. 65. A name or epithet of a taxonomic group must be rejected when it is based on a monstrosity

Art. 66. The name of an order, suborder, family or subfamily, tribe or subtribe must be changed when it is taken from the name of a genus which is known not to belong to the group in question-e g. if the genus Portulaca were excluded from the family now known as Portulacaceae, the residual group could no longer bear the name Portulacaceae, and would have to be renamed,

Art. 67. Names of genera are illegitimate in the following special cases and must

be rejected:

(1) When they are merely words not intended as names, e.g. Anonumous Walt. (Ft. Carol, 2, 4, 9, etc. 1788) must be rejected as being a word applied to 28 different genera by Walter to indicate that they were without names.

- (2) When they coincide with a technical term currently used in morphology unless they were accompanied, when originally published, by specific names in accordance with the binary method of Linnseus On and after Jan. 1. 1912, all new generic names coinciding with such technical terms are unconditionally rejected.
- (3) When they are unitary designations of species e.g. Ehrhart (Phytophylacium: 1780; and Bette, iv, 145-150 1795) proposed unitary names for various species known at that time under binary names: e g Photocephalum for Schoenus fuscus, and Leptostachys for Carex leptostachys These names. which resemble generic names, should not be confused with them, and must be rejected, unless they have been published as generic names by n subsequent author.
- (4) When they consist of two words, unless these words were from the first combined into one, or joined by a hyphen

Art, 65. Specific epithets are illegitimate in the following cases and must be rejected:

(1) When they are merely words not intended as names.

(2) When they are merely ordinal adjectives being used for enumeration.

(3) When they exactly repeat the generic name with or without the addition of a transcribed symbol,

(4) When they were published in works in which the Lanneau system of binary

nomenclature for species was not consistently employed.

In cases foreseen in Art, 60-65 the name or epithet to be rejected in replaced by the oldest legitimate name, or (in a combination) by the oldest legitimate epithet. If none exists, a rew name or epithet must be chosen. Where a new epithet is required, an author may, if he nishes, adopt an epithet previously given to the group in an illegitimate combination, if there is no obstacle to its employment in the new position or sense.

#### Section 15. Onthography of Norms (Art. 70-71. the XXXVIII-XLIV)

Art. 70. The original spelling of a name or spatiet must be retained, except in the case of a typographic error, or of a clearly unintentional orthographic error. When the difference between two generic names has in the termination, these names must

<sup>&</sup>quot;Appendix VI Las not been published as yet.

be regarded os distiact, even though differing by one letter only. This does not opply to mere orthographic various of the same name.

Note 1. The words "originol spelling" in this Article mean the spelling employed when the name was validly published.

2. The use of a wrong connecting vowel or vowels (or the omission of a connecting vowel in a specific epithet, or in that of a subdivision of a species) is treated as an unintentional orthographic error which may be corrected (see Rec. XLIV). "The liberty of correcting a name must be used with reserve, especially if the change affects the first sylloble, ond obove all the first letter of the name." (Added at the Amsterdam Botanical Congress, 1935.)

3. In deciding whether two or more slightly different names should be treated as distinct or as orthogrophical variants, the essential consideration is whether they may be confused with one another or not; if there is serious risk of confusion, they should be treated as orthographic variants. Doubtful cases should be referred to the Execu-

tive Committee.

4. Specific and other epithets of Greek origin differing merely by having Greek and Latin terminations respectively no orthogrophic variants. Epithets bearing the same meaning and differing only slightly in form are (considered as) orthographic variants. The genitive and adjectival forms of a personal name are, however, treeted as different epithets (e.g. Lysimachia Hemsleyana and L. Hemsley).

Recommendations:

XXXVIII. When a new name is derived from a Greek word containing the spiritus asper (rough breathing), this should be transcribed as the letter it.

XXXIX. When a now nome for a genus, subgenus or section is token from the nome of a person, it should be formed in the following manner --

(a) When the name of the person ends in a vowel the letter a is added (thus Boulelous after Boutelou; Ollos after Otto; Sloants after Sloane), except when his name already ends in a, when a is added (e.g. Collass after Colla).

(b) When the name of the person ends in a consonant, the letters is are added (e.g. Magnusia after Mognus, Ramondia ofter Ramond), except when the

aame ends ia er,, whea a is added (e.g. Kernera ofter Kerner).

(e) The syllables which are not modified by these endings, retain their original spelling, even with the consonants k and we or with groupings of wowels which were not used in classical Latin. Letters foreign to botanical Latin should be transcribed, and discritic signs suppressed. The Germanic â, â, û become ac, oc, uc, the French ê, 2, ê become generally c. In works in which diphthongs ore not represented by special type, the diacresis sign should be used where required, e.g., Cephallis, not Cephallis.

(d) Names may be accompanied by a prefix or a suffix, or modified by onagram or abbreviation. In these cases they count as different words from the

original name.

Examples: Durrillea and Urrillea; Lapeyrousea and Peyrousea; Englera, Englerastrum and Englerella; Bouchea and Ubochea; Gerardia and Graderia.

XL. When a new specific or other epithet is taken from the name of a man, it should be formed in the following manner:

(a) When the name of the person ends in a vowel, the letter i is added (thus Glazioui from Glaziou, Bureaui from Bureau), except whea the name ends in a when e is added (thus balansae from Balansa).

(b) When the name ends in a consonant, the letters it are added (thus Magnusii from Magnus, Ramondis from Ramond), except when the name ends in -er when a is added (thus Kerneri from Kerner).

(c) The syllables which are not modified by these endings retain their original spelling, even with the consonants k or w or with groupings of youcle which were not used in classical Latin. Letters foreign to botanical Latin should be transcribed and discritic signs suppressed. The Germanic &. &. a become ac, oc, ou, the French &, &, & become generally e. The discresis sign should be used where required.

(d) When epithets taken from the name of a person have an adjectival form they are formed in a similar way (e.g. Geranium Robertianum, Verbena

Hasslerana) XLI. The same provisions apply to epithets formed from the names of women. When these have a substantival form they are given a feminine termination (e.g.

Cupripedium Hookerge, Rosa Beatricis, Scabiosa Olgae, Omphalodes luciliae). . XLII. The specific (or other) epithets should be written in conformity with the original spelling of the words from which they are derived and in accordance with

the rules of Latin and latinization.

Examples silvestris (not sylvestris) sinensis (not chinensis).

XLIII. Specific (or other) conthets should be written with a small initial letter. except those which are derived from names of persons (substantives or adjectives), or are taken from generic "or vernacular" names (substantives or adjectives). (Emended Amsterdam Rotanical Congress, 1935. See page 61 for actions taken by Second International Microbiological Congress, London, 1936 governing Bacteriologicai Nomenciature l

XLIV. In the formation of specific for other) epithets composed of two or several roots taken from Latin or Greek, the vowel placed between the two roots becomes a connecting you cl, in Latin i, in Greek o, thus menthifolia, sali ifolia, not menthaefolia, salviafolia. When the second root begins with a vowel and euphony requires, the connecting your should be chiminated (c g lepidantha). The connecting vowels as should be retained only where this is required for etymological reasons (e.r. caricaeformis from Carica, in order to avoid confusion with carrenformis from Carez). In certain compounds of Greek words no connecting vowel is required, a g brackycarpus and glucylphyllus

# Section 14. Gender of Generic Names

- Art. 72. The gender of generic names is governed by the following regulations:-
- (1) "A Greek or a Latin word adopted as a generic name retains its classical cender. In cases where the classical gender varies, the author has the right of choice between the alternative genders. In doubtful cares, general usage should be followed." "The following names, honever, whose classical cender is masculine, are treated as feminine in accordance with historic usage: Adones, Orches, Stochus, Diospyros, Struchnos, Hemerocalles (m. in So. Pl., Lat and Gr. hemercalles n ) is also treated as femining to bring it into conformity with all other generic names ending in is." (Emended Amsterdam Botameal Congress, 1935 ) See Van Esciting, Jour. Bact . 20. 1933, 569, for discussion of the gender of generic names used for bacteria.

(2) Generic names which are modern compounds formed from two or more Greek or Latin words take the gender from the last. If the ending is aftered,

however, the gender will follow it.

(3) Arbitrarily formed generic names or vernacular names used as ceneric names take the render assigned to them by their authors. Where the original author has failed to indicate the gender, the next subsequent author has the right of choice.

Section 15. Various Recommendations (Rec. XLV-L)

XLV. When writing in modern languages botanists should use Latin scientific names or those immediately derived from them, in preference to names of another kind or origin (popular names). They should avoid the use of the latter unless these are very clear and in common use.

XLVII. Only the metric system should be used in botany for reckoning weights and measures. The foot, inch, line, pound, onnee, etc., should be rigorously evaluded from scientific language.

Altitude, depth, rapidity, etc., should be measured in meters. Fathoms, knots, miles, etc., are terms which should disappear from scientific language.

XLVIII. Very minute dimensions should be reckoned in  $\mu$  (micromillimeters, microns, or thousandths of a millimeter) and not in fractions of millimeters or of lines, etc. fractions encumbered with ciphers and commas easily give rise to mistakes.

XLIX. Authors should indicate clearly and precisely the scale of the figures which they publish.

L. Temperatures should be expressed in degrees of the centigrade thermometer of Celsus.

Chapter IV. Interpretation and Modification of the Rules (Art. 78, 74)

Art. 73. A small permanent International Executive Committee is established with functions including the following:

 Interpreting the Rules in doubtful cases, and issuing considered "Opinions" on the basis of the evidence submitted.

(2) Considering Nomina conservanda, Nomina ambigua, Nomina dubia and

Nomina confusa, and making recommendations thereon to the next International Botanical Congress

(3) Considering all proposals for the modification of the Rules and reporting thereon to the next Congress.

(4) Reporting on the effects of modifications of the Rules accepted at the preceding Congress.

Art. 74. These Rules can be modified only by competent persons at an Internacional Botanical Congress convened for the express purpose. Modifications accepted at one Congress remain on trad until the next Congress, at which they will receive sanction unless undesirable consequences, reported to the Executive Committee, show need for further amendment or rejection.

Eight appendices have been or are to be prepared for this Code as follows: (1) †Regulations for determining types, (2) †Nomina conservanda familiarum, (3) \*Nomina generica conservanda, (4) †Nomina ambigua, (5) †Nomina dubia, (6) †Nomina confusa, (7) \*Representative botanical institutions recognized under Art. 34, (8) †Nomenclature of garden plants.

Unfortunately the first appendix which is of greatest interest to bacteriologists has not been prepared. As many bacteriologists, especially those in other countries, have not caught the significance of the type species

<sup>\*</sup>These appendixes have been prepared.

<sup>†</sup>These appendixes have not been published as yet.

concept as a means of defining bacterial genera, the reader is referred to the writings of Hitchcock (Amer. Jour. Bot., 8, 1921, 251; Descriptive Systematic Botany, New York, 1925) for an excellent exposition of the value of this idea to systematists.

Hitchcock (1921, p. 252) explains this concept briefly as follows: "The old concept was that a genus was a group of species having a given combination of characters; a species, similarly, a group of specimens. The new type concept is that, from the nomenclatural standpoint, a genus is a group of species allied to the type species; a species, a group of individuals similar to the type specimen."

Rules for determining types taken from the Type Basis Code of Nomenclature (Science, 49, 1919, 333, 53, 1921, 312) drawn up by a Committee of which Hitchcock was Chairman are quoted as these are the most authoritative rules thus far available.

## Tupe Basis Code of Nomenclature (Hitchcock et al.)

Article 4. The nomenclatural type species of a genus is the species or one of the species included when the genus was originally published.

If a ganus included but one species when originally published, this species is the type.

When more than one species is included in the original publication of the genus. the type is determined by the following rules (a) When, in the original publication of a genus, one of the species is definitely

designated as type, this species shall be accepted as the type regardless of other considerations. If typicus or typus is used as a new specific name for one of the species, this species

shall be accepted as the type as if it were definitely designated

(b) The publication of a new generic name as an avowed substitute for an earlier

synonym, that species is to be accepted as the type.

(d) If a genus, when originally published, includes more than one species, and no species is definitely designated as type, nor indicated according to (e), the choice of the type should accord with the following principles.

1. Species inquirendae or species doubtfully referred to the genus, or mentioned as in any way exceptional are to be excluded from consideration in selecting the type

2 Genera of the first edition of Linnaeus's "Species Plantarum" (1753) are usually typified through the citations given in the fifth edition of his "Genera Plantarum" (1751) except when inconsistent with the preceding articles \*\*\* 41 -

#### RECOMMENDATIONS

Article 5. In the future it is recommended that authors of generic names definitely designate type species; and that in the selection of types of genera previously published, but of which the type would not be indicated by the preceding rules, the following points be taken into consideration:

- (a) The type species should usually be the species or one of the species which the author had chiefly in mind. This is often indicated by
  - 1. A closer agreement with the generic description.
  - 2. Certain species being figured (in the same work).
  - 3. The specific name, such as rulgoris, communis, medicinalis or officinalis,

(b) The type species should usually be the one hest known to the author. It may be assumed that an indigenous species (from the standpoint of the author), or an economic species, or one grown in a botanical garden and examined by the suthor, would usually represent an author's idea of a genus.

(c) In Linnaean genera the type should usually be chosen from those species included in the first technical use of the genus in pre-Linnaean literature.

(d) The types of genera adopted through citations of non-hinomial literature (with or without change of name) should usually be selected from those of the original species which received names in the first hinomial publication.

(e) The preceding conditions having been met, preference should be shown for a species which will retain the generic name in its most widely used sonso, or for one which belongs to a division of the genus containing a larger number of species, or, especially in Linnacan genera, for the historically oldest species.

(f) Among species equally eligible, the preference should be given to the first known to have been designated as the type.

(g) If it is impossible to select a type under the conditions mentioned above, the first of equally eligible species should be chosen.

While the rules and recommendations of the above botanical codes are applicable in general to bacteria and related microorganisms, the fact that these are not infallible is evident because the rules developed independently by zoologists (see Proc. Biol. Soc. Washington, 39, 1926, 75, for the latest Code of Zoological Nomenclature) frequently follow a quite different course. In some cases at least the zoological rules will appeal to microbiologists as more likely to produce uniformity of usage than the botanical rules.

For example, microbiologists assembled at the Second International Microbiological Congress in London, 1936 accepted (Jour. Bact., 33, 1937, 445) Art. 13 of the International Rules of Zoological Nomenclature as preferable to Rec. 43 of the Botanical Rules to govern bacteriological practice. This reads as follows: "While specific substantive names derived from names of persons may be written with a capital initial letter, all other specific names are to be written with a small initial letter. Some examples taken from bacteriological literature are: Salmonella Schottmuelleri or Salmonella schottmuelleri, Bacillus Welchii or Bacillus welchii, Acetobacter Pasteurianum or Acetobacter pasteurianum, Corynebacterium ovis, Nitrosomonas javanensis, Rhizobium japonicum."

In the MANUAL all species names are written with a small letter. It is felt that the value of a name as a name is lessented if capitals or other marks are used to indicate etymology. The derivation of generic and specific names is given separately in the describitive material.

Likewise for obvious reasons, microbiologists refused (Jour. Bact., 33, 1937, 445) to follow the botanical and zoological practice which permits the use of duplicate generic names, one for an animal and the other for a plant group; and accepted the following rules to govern their practice.

"a. Generic homonyms are not permitted in the group Protesta

b. It is advisable to avoid homonyms amongst Protesta on the one hand, a plant or animal on the other."

The following actions of the International Committee on Bacteriological Nomenclature (Cent. f. Bact., II Abt., 92, 1935, 481) were confirmed (Jour. Bact., 33, 1937, 445).

Bacillus Cohn 1872 was accepted as a genus conservandum with Bacillus subillis Cohn emend. Prazmowski 1880 as type species. It was agreed that Bacillus should be defined so as to exclude bacterial species which do not form endospores; and that the so-called Marburg strain found in type culture collections should be accepted as the type or standard strain.

At the Third International Congress of Microbiology held in New York City in September, 1939, a series of recommendations of the Permanent International Committees on Bacteriological Nomenclature were accepted at the plenary session of the Congress. The third and fourth recommendations were:

3. That the Nomenciature Committee, as at present constituted, shall continue to function under the auspices of the International Association of Microbiologists

as it did under the International Society for Microbiology.

4. That the International Commutee shall select from its membership a Judicial Commission consisting of twelve members, exclusive of members 22 office, and shall designate a Chairman from the membership of the Commission. The two Permanent Secretaries of the International Commistion on Bacterological Nomenclature shall be members 22 offices of the Judicial Commission. The Commissioners shall serve in three classes of four commissioners each for nine years, so that one class of four commissioners shall retrie at every International Congress. In case of the resignation or death of any Commissioner, his place shall be filled for the unexpired term by the International Committee at its next meeting.

By prompt action at and subsequent to the Congress ballots were cast in spite of war conditions by 26 of the 62 members of the Permanent Committee on Nomenclature. These ballots when examined by the joint Secretaries of the Permanent Committee in November, 1942 were found to have resulted in the selection of the persons whose names appear below. These are grouped in the three classes specified by the Permanent Committee, those receiving the highest number of votes being placed in the nine year class, those receiving the next highest in the six year class, etc. Names in the classes are arranged alphabetically.

Elected for nine years.—(The term normally expires in 1948.) R. E. Buchanan (U.S.A.), A. J. Kluyver (The Netherlands), E. G. D. Murray (Canada), S. Orla Jensen (Denmark): Elected for six years.—(Term normally expires in 1945.) J. Howard Brown (U.S.A.), A.-R. Prévot (France), J. Ramsbottom (Great Britain), Th. Thjötta (Norway); Elected for three years.—(Term normally would have expired in 1942) A. Lwoff (France), R. Renaux (Belgium), A. Sordelli (Argentine), C. Stapp (Germany).

This announcement was made (Sci., 97, 1943, 370) in the hope that some plan for taking tentative action on questions of nomenclature could be developed by those members of the Commission who could be reached under war conditions.

While no provision was made in 1939 for the contingencies that have arisen, it is felt that those elected should serve until successors are elected. Professor R. E. Buchanan has been asked to act as Chairman pro ten of the Judicial Commission as there is no possibility of securing an election under the rules as adopted.

Tentative International Rules of Bacteriological Nomenclature were presented to the Third International Congress of Microbiology by a U.S.A.-Canadian Committee on Compilation of Proposals on Bacteriological Nomenclature. As it proved impossible to give adequate consideration to these proposals during the Congress, the following recommendations of the Permanent Committee on Nomenclature were accepted:

1. That a recognized Bacteriological Code be developed.

That publication of such a proposed Code, when developed, be authorized with the provise that it shall be regarded as wholly tentative, but in the hope that it shall be widely tested so that it may be brought up for further consideration and final disposition at the next Microbiological Congress which should normally take place in 1942.

Copies of this tentative Code have been issued in mimeographed form by Prof. R. E. Buchanan, Iowa State College, Ames, Iowa, U.S.A., Chairman of the U.S.A., Canadian Committee and may be obtained from him.

# CLASS SCHIZOMYCETES NÄGELI

(Bericht Verhandl. d. bot. Section d. 33 Versammling deutsch. Naturforsch. u. Arzt. Bot. Ztg., 1857, 760)

Synonyma: Bacteria Cohn, Bett. Biol d. Pflanzen, 1, Heft 1, 1872, 136; Bacteria eeca Cohn, ibid., 237; Bacteriales Clements (as an ordinal name), The Genera of Fungi, Minneapolis, 1909, 8, Schizomycetacea De Toni and Trovisan, in Saccardo, Sylope Fungorum, 8, 1889, 923; Schizomycetacea Castellani and Chalmers, Manual of Tropical Medicine, 3rd ed., 1919, 923; Mychota Enderlein, Bakteriencyclogenie, 1924, 236; Schizomyceta Stanier and Van Niel, Jour Bact, 42, 1941, 458.

Typically unicellular plants Cells usually small, sometimes ultramicroscopic. Frequently motile. As in the closely related blue-green algae (Class Schizophyceae). the cells lack the definitely organized nucleus found in the cells of higher plants and animals. However, bodies containing chromatin which may represent simple nuclei are demonstrable in some cases Individual cells may be spherical; or straight, curved or spiral rods. These cells may occur in regular or irregular masses or even in cysts. Where they remain attached to each other after cell division they may form chains or evon definite filaments. The latter may show some differentiation into holdfast cells, and into motile or non-motile reproductive cells (conidia) Some grow as branching mycelial threads whose diameter is not greater than that of ordipary bacterial cells, i.e., about one micron Some species produce pigments. The true purple and green bacteria possess pigments much like or related to the true chlorophylls of higher plants. These pigments have photosynthetic properties The phycocyanin found in the blue green algae does not occur in the Schizomycetes Multiplication is typically by cell division. Endospores are formed by some species included in Eubacteriales. Sporocysts are found in Myzobacteriales Ultramicroscopic reproductivo bodies are found in Borrelomycetaceae. The bacteria are freeliving, saprophytic, parasitle or even pathogenic. The latter types cause diseases of either plants or animals. Seven orders are recognized.

# Key to the Orders and Sub-Orders of the Class Schizomycetes.

- Cells rigid, not flevious. Motility by means of flagella or by a gliding movement.
   Cells single, in chains or masses. Not branching and mycelial in character. Not arranged in filaments. Not acid-fast. Motility when present by means of flagella.
  - Order I. Lubacteriales, p. 66.
  - a. Do not possess photosynthetic pigments Cells do not contain free sulfur.

    h. Not attached by a stalk. Do not deposit ferrie hydroxide.

    Sub-Order I. Eubacterinaer, p. 67.
    - bb, Attached to substrate, usually by a stalk. Some deposit ferric hydroxide.
  - Sub-Order II. Caulobacterineae, p. 827.
    an. Possesses photosynthetic chlorophyll-like pigments Some cells contain
    - Sub-Order III. Rhodobacteruneae, p. 838.

free sulfur.

Organisms forming elongated usually branching and mycelial cells. Multiply by cell division, special spores, oidiospores and conidia. Sometimes acid-fast. Non-motile.

Order II. Actinomycetales, p. 895.

Cells in filaments frequently enclosed in a tubular sheath with or witbout a deposit of ferric hydrovide. Sometimes attached. Motile flagellate and non-motile conidia. Filaments sometimes motile with a gliding movement. Cells sometimes contain free sulfur.

Order III. Chlamydobacteriales, p. 981.

B. Cells flexuous, not rigid.

1. Cells elongate. Motility, by ereeping on substrate

Order IV. Myzobacteriales, p. 1005,

2. Cells spiral. Motility, free swimming by flexion of cells.

Order V. Spirochaetales, p. 1051.

Supplements: Groups whose relationships are uncertain.

- 1. Obligate intracellular parasites or dependent directly on living cells.
  - Not ultramicroscopic and only rarely filterable. More than 0.1 micron in diameter.

Group I. Order Rickettsiales, p. 1083,

aa. Usually ultramicroscopic and filterable. Except for certain pox viruses of animals and a few plant viruses, less than 0.1 micron in diameter.

Group II. Order Virales, p. 1128.

Grow In cell-free culture media with the development of polymorphic structures including rings, globules, filamonts and minute reproductive bodies (less than 0.3 micron in diameter).

Group III. Family Borrelomycetaceae, p. 1201.

#### ORDER I. EUBACTERIALES BUCHANAN.

(Jour. Bact., 2, 1917, 162.)

Simple and undifferentiated rigid cells which are either spherical or rod-shaped. The rods may be short or long, straight or curved or spiral. Some groups or species are non-mottle, others show locomotion by means of flagella. Elongated cells divide by transverse fission and may remain attached to each other in chains. Spherical organisms divide either by parallel fission producing chains, or by fission alternating in two or three planes producing thus either tetrads or cubes of 8 and multiples of 8 cells. Many spherical cells form irregular masses in which the plane of division eannot be ascertained. Endospores occur in some species. Some species are chromogenic, but only in a few is the pigment photosynthetic (bacteriochlorophyll or other chlorophyll-like pigments).

A group of rather large, spherical to short rod-shaped, colorless sulfur hacteria, which some feel should be included in the order Eubacteriales, has heen attached as an Appendix to the order Chlamydobacteriales on account of the physiological similarity between the former organisms and the Beggialoaceae. These are in Family Achromaticacea, p. 997.

#### Eubacterlineae Breed, Murhay and Hitchens. Sub-Order I (Jour. Bact., 47, 1944, 421.)

These are, as the name Eubsetermas implies, the true bacteria in the narrower sense of the word The cells are ngid and free. Branching occurs only under abnormal conditions of life They are not attached by holdfasts nor stalks They form no sheaths. One-third of the species form pigments, but these have no photosynthetic properties Endospores occur in one family (Bacillaceae), rarely in others

# Key to the Families of the Sub-Order Eubacteriineae.

- I. No endospores (except Sporosurcina)
  - A. Can develop on morganic media Autotrophic and facultative autotrophic. Family I. Nitrobacteriaceae, p 69
    - B. Cannot develop on morganic media (exceptions, see Family XII Bacteriaceae). Heterotrophic
      - 1. Polar flagellate, straight, curved or spiral rods Gram-negative. (Some species with a single flagellum will be found under Family IV Rhizobiaceae. Family V Micrococcaceae and Family VIII Corynebacteriaceae). Family II Pseudomonadaceae, p 82
        - 2. Large, oval, pleomorphic cells sometimes almost yeast-like in appearance Free living in soil Fix free mtrogen. Peritrichous flagellation
          - Family III Azotobacteriaceae, p. 219
        - 3. Peritriehous or non-motile rods, and eocei.
          - a Heterotrophic rods which may not require organic nitrogen for growth, Usually motile with one to six or more flagella. Usually form nodules or tubercles on roots of plants, or show violet chromogenesis. Family IV Rhizobiaceae, p 223
            - as Heterotrophic rods or cocci which utilize organic nitrogen and usu-
          - ally carbohydrates b Spherical cells in masses, tetrods, and packets. A few species are
            - motile with one or two flagelia.
              - c. Gram-positive to Gram-negative cocci. Not obligate parasites. Family V. Micrococcacene, p. 235.
              - ce Gram-negative, and sometimes anaerobic coces Obligate parasites
                - Family VI. Neusseriaceae, p 295.
            - bb Spherical cells which grow in pairs and chains, and rods e Gram-positive cocet and rods Non motile (some species of Streptococcaceae or Corynebacteriaceae may show motility).
              - d Microaerophilic to anaerome cocci and rods. Frequently in chains. Active in the fermentation of sugars. Never reduce nitrates
              - Family VII. Lactobacteriaceae, p. 305. dd Usually aerobic, but sometimes anaerobic rods. Less
              - active in the fermentation of sugars. May or may not reduce nitrates.
                - Family VIII. Corynebacteriaceae, p. 381

- cc. Gram-negative rods. When motile, from four to many peritrichous flagella.
  - Grow well on ordinary media containing peptone. Aerobic to facultative anaerobic.
    - e. Gram-negative, straight rods which ferment sugars with the formation of organic acids.
      - Produce little or no acid in litmus milk. May or may not reduce nitrates. Many yellow chromogens. Borderline between this and following family indistinct. Some species anaerobic.
      - Family IX. Achromobacteriaceae, p. 412.

        ff. Produce CO<sub>2</sub> and frequently visible gas (CO<sub>2</sub> + ...
      - H<sub>2</sub>) from glucose. Reduce nitrates. Usually from the alimentary, respiratory or urinary tract of vertebrates, though some are free-living or even plant parasites.

Family X. Enterobacteriaceae, p. 443.

dd. Small Gram-negative rods. Obligate parasites which usually require body fluids for growth. Do not grow well on ordinary media. Some are anaerobic.

Family XI. Pariobacteriaceae, p. 545.

ccc. Rods of varied types not included in above families. Aerobic to facultative anaerobic.

Family XII. Bacteriaceae, p. 596.

Form endospores. Large rods, sometimes in chains. Aerobic to anaerobic.

Family XIII. Bactillaceae, p. 704.

#### \*FAMILY I. NITROBACTERIACEAE BUCHANAN

(Jour. Bact., £, 1917, 319 and Jour. Bact., 5, 1918, 179.)

Cells without endospotes. Rod-shaped or ellipsoidal except for one spherical species (Nitroscoccus nitrosus) Spiral rods in Nitrosoppira and in one species of Thiobaciflus. Tagella ether polar (so far as koom), or absent. Gram stain uncertain, but presumably Gram-negative for all of the polar flagellate, rod-shiped species except for Nitrosomonas monocella which is reported to be Gram-positive. Capable of growing without organe compounds, using CO<sub>3</sub> as the source of carbon, and obtaining their energy by oxidation of ammonia, nitrite, hydrogen, sulfur, or thiosulfate. Some species can also utilize organic compounds. Non-parasitic, usually soil or water forms

#### Key to the tribes and genera of family Nitrobacterlaceae.

 Organisms oxidize ammonia to mitrite, or mitrite to mitrate. Growth on standard media very poor or absent.

Tribe 1. Netrobactericae, p 70.

Cells axidize ammonia to natrite
 Cells are separate, free or in dense aggregates
 Do not form roogloca.

c. Cells ellipsoidal

Genus I. Nitrosomonas, p. 70.

cc. Cells spherical.

Genus II. Natrosococcus, p. 71.

eec. Cells spiral.

Genus III. Nifrosospira, p. 71.

bb. Cells form a roogloca

e. The receives as surrounded by a common membrane forming a cyst.

Genus IV Nitrosocystis, p. 72.

ee. The massed cells are embedded in slime. No common membrane surrounds the cells

Genus V. Nitroseplora, p. 73.

aa. Cells oxidize nitrite to nitrate b. Cells form no roccioca

Genus VI Nutrobacter, p 74.

ib. Cells form a receives

Genus VII. Astrocystus, p. 75

It. Organisms oxidize hydrogen.

Tribe II llydrogenomonaticae, p. 76

a Aerobic, non-spore forming rods with single polar flurellium, or reconvible Genus L. Hydrogrammenas, p. 76

<sup>\*</sup>Text revised by Prof. R. S. Breed and Prof. R. J. Gonn, General, N. Y., Dec., 1937. Completely revised by Dr. R. L. Starkey, New Jersey Arricalized Experiment Station, New Figurascuk, N. J., March, 1931.

- C. Organisms oxidize sulfur or thiosulfate and similar inorganic compounds of sulfur.
  - Tribe III. Thiobacilleae, p. 78.
  - a. Aerobic to anaerobic, non-spore-forming rods with a single polar flagellum on each (so far as known), or non-motile.

Genus I. Thiobacillus, p. 78.

#### TRIBE I. NITROBACTERIEAE WINSLOW ET AL.

(Jour. Bact., 5, 1920, 201.)

Organisms deriving energy from the oxidation of ammonia to nitrite or from nitrite to nitrate and depend on this oxidation for growth. Fail to grow on media containing organic matter in the absence of the specific inorganic materials used as sources of energy. Many organic compounds commonly used in standard culture media are toxic to this group.

### Genus I. Nitrosomonas Winogradsky.

(Nitromonas Winogradsky, Ann. Inst. Past., 4, 1890, 257; Arch. Sci. biol., St. Petersburg, 1, 1892, 127; emend. S. and H. Winogradsky, Ann. Inst. Past. 50, 1933, 350)

Cells ellipsoidal, non-motile or with a single polar flagellum, occurring singly, in pairs, sbort chains or irregular masses, which are not enclosed in a common membrane. Oxidize ammonia to nitrite more rapidly than the other genera of this tribs. From Latin, nitrosus, full of soda; M.L. nitrous; and Greek monas, a unit; M.L. a monad.

The type spacies is Nutrosomonas europaea Winogradsky.

1. Nitrosomonas europaea Winogradaky. (Arch. Sci. biol., St. Patersburg, 1, 1892, 127; Baclerium nitrosomonas Lehmann and Neumann, Bakt. Diag., 2nd ed., 2, 1899, 187; Pseudomonas europaea Migula, in Engler and Franti, Dis natūri. Pflanzenfam, 1, 1a, 1895, 29; Plancececus europaeus Vuillemin, Ann. Mycologie, Berlin, 11, 1913, 525.) From Latin, europaeus, of Europe.

Rods: 0 9 to 1.0 by 1.1 to 1.8 microns occurring singly, rarely in chains of three to four. Possess a single polar flagellum 3 to 4 times the length of the rods, or rarely one at either end.

Grow readily in aqueous media without organic matter, and containing ammonium sulfate, potassium phosphate, and magnesium earbonate. The cells accumulate in soft masses around the particles of magnesium earbonate at the bottom of the flask. The liquid is occasionally turbid through development of motile swarmer cells or manads. Small, compact, sharply defined colonics brownish in color on silica gel. Aerobic.

Meropie,

Strictly autotrophic.

Source: Soils of Zurich, Switzerland; of Gennevilliers, France; and Kazan, Russia.

Habitat: Presumably widely distributed in soil.

- la. Nitrosomonas europaca var. italica Perotti (Rendic. d. Accad. d. Lincei Roma, 16, 1906, 516; Abs. in Cent. f. Bakt., II Abt., 19, 1907, 337). Also see Engel and Skallau (Cent. f. Bakt., II Abt., 97, 305, 1937).
- Nitrosomonas monocella Nelson. (Cent. f. Bakt., II Abt., 85, 1931, 287.)
   From Greek monos, single and Latin cella, room; M.L. single cell.

Ovoid rods: 0.6 to 0.9 micron, often occurring in pairs. Young cells nearly spherical. Motile by means of a single polar flagellum 3 to 5 times as long as the rod. Gram-positive (Nelson) Found negative by H. J. Conn (personal communication).

No growth in nutrient broth, nutrient agar, nutrient or plain gelatin, plain or litmus milk, glucose or plain yeast

water, or on potato.

Silica gel or agar plates of inorganic medium: No typical colonies, but yellowish brown masses of growth around particles of CaCO, in the medium

Inorganic liquid medium containing ammonium salts: Uniform development throughout the liquid as well as in the carbonate sediment.

Even low concentrations of organic matter retard or completely inhibit the initiation of growth. Plant extracts are toole, Free CO<sub>2</sub> and O<sub>2</sub> necessary for growth.

Optimum pH 8.0 to 9.0. Poor growth
below pH 7.0. Some growth above pH
90.

Optimum temperature for growth and oridation 25°C.

Aerobie.

Strictly autotrophic.

Source: Isolated from field soil.

Habitat: Presumably widely distributed in soil.

S Winogradsky and H. Winogradsky (Ann. Inst. Pasteur, 50, 1933, 301) have described 5 cultures of Nitrosomonoss which were obtained from soils of France. An additional culture has been described by H. Winogradsky (Ann. Inst. Pasteur, 58, 1937, 393) from activated sludge.

# Genus II Nitresococcus Winogradsky.

(Arch Sci. biol , St Petersburg, f, 1892, 127.)

Cord benammania to nitrite.

1. Nitrosecceus nitrosus (Aiguits) Bergey et al. (Nitrosecceus Winogradsky, Ann. Inst. Pasteur, 5, 1801, 577, Arch. Sei. biol., St. Petersburg, I, 1892, 127; Microceccus nitrosus Miguits, Syst. d. Bakt., 2, 1900, 191; Nitrosecceus americanus Buchanna, Jour Bact., 3, 1918, 180; Manual, 2nd ed., 1923, 35 ) From Latin, nitrous, full of soita, M. L. nitrous Large spheres, 1 5 to 17 microus in

size, with thick cell membrane. Motility could not be demonstrated Stains readily with aniline dyes. Observed no zoogloca formation. Gram-positive

(Omehanski, Cent f. Bakt, II Abt., 19, 1907, 263)

Liquid medium Turbidity

Since gel. Both dark and light colonies Surface colonies look like small drops of a turbid yellowish liquid.

Aerobic.

Optimum temperature 20° to 25°C.

Source: Isolated from soil from Quito, Ecuador; Companias, Brazil, Melbourne, Australia.

Habitat: Presumably widely distributed in soil

# Genus III. Nitrosospira Winogradsky.

(Compt. rend. Acad. Sci., Paris, 192, 1931, 1991; Ann. Inst. Pasteur, 59, 1933, 400.)

Cells spiral-shaped. Osidise ammonia to nitrite very slowly. From Latin, nitrosus, full of sods; and spira, coil, spiral; M.L. nitrous spiral.

The type species is Nitrosospira briensis Winogradsky.

 Nitrosospira briensis Winogradsky (Ann. Inst. Pasteur, 50, 1933, 407.) From French, Brie, a place name; M.L. of Brie.

Spirals wound tightly to form very small cylinders as long as 15 to 20 microns. Short spirals have the appearance of sbort rods and ellipsoidal cells. Small pseudo-cocci were observed in old cultures.

Colonies on silica gel: Small colonies which occasionally contain cyst-like aggregates of cells. The cysts are more poorly developed than in Nitrosocystis.

Aerobic. .

Reaction optimum: pH 7.0 to 7.2.

Source: Uncultivated pasture soil of Brie, France.

Habitat: Presumably widely distributed in soil.

 Nitrosospira antarctica Winogradsky. (Ann. Inst. Pasteur, 50, 1933, 407.)
 From Greek, antarkitos, soutbern, antarctic.

Cells and colonies similar to N. briensis except that the cells are generally wound together to form more compact spirals.

Aerobic.

Reaction optimum: pH 7.0 to 7.2 Source: Soil from the Antarctic.

Habitat: Presumably widely distributed in soil.

# Genus IV. Nitrosocystls Winogradsky.

(Compt. rend. Acad Sci., Paris, 192, 1931, 1003; Ann. Inst. Pasteur, 50, 1933, 399.)

Cells ellipsoidal or elongated, unuting in compact, rounded aggregates surrounded by a common membrane to form cysts. The cysts disintegrate to free the cells are intelligrate when transferred to fresh media. Within the cyst, the cells are embedded in slime. Oxidize ammonia to nitrite at a rate intermediate between Nitrosomonas and Nitrosospira. From Latin, nitrosus, full of soda; and Greek, kystis, bladder; M.L. nitrous cyst.

The type species is Nitrosocystis javanensis comb. nov.

1 Nitroscoystis javanensis comb. nov. (Nitroscopsus javanensis Winogradsky, Arch. Sci. hol, St. Petersburg, I, 1892, 127, Petudomonas javanensis Migula. In Engler and Prantl, Die naturl. Pflanzenfam, I, 1a, 1895, 30, Compt rend. Acad Sci, Paris, 182, 1931, 1003.) From Latin, of Java.

Small ellipsoidal cells having a diameter of 0 5 to 0.6 micron. Possess a polar flagellum 20 times as long as the rods

In liquid medium produces very compact zoogloeal masses of cells and motile swarmers. The large zoogloea are themselves composed of smaller compact aggregates of cells.

On silica gel the colonies are circular to elliptical becoming clear or light brown. Aerobic.

Strictly autotrophic.

Source: Soil of Buitenzorg, Java; Tokyo, Japan; La Reghaia, Tunisia. Habitat: Presumably widely distributed in soil.

 Nitrosocystis coccoldes nom. nov. (Nitrosocystis a, S Winogradsky and H. Winogradsky, Ann. Inst. Pasteur, 60, 1933, 401.) From Greek, kokkos, a grain; eidos, form, shape; M.L. coccus-like.

Ellipsoidal cells about 1.5 microns in diameter. Occur as compact aggregates of cells imbedded in mucus and surrounded by a thickened capsule to form cyst-like bodies. Cells rarely solitary but more often in pairs and in small groups of four or more. Probably motile. The mucus which surrounds the cells is not readily stained, whereas the outside coating stains more easily.

Colonies on silica gel: As colonies develop, the coating of CaCO<sub>1</sub> on the gel becomes yellowish and dissolves and the colony appears as a bulbous, angular, brown body which may become 0.5 mm in diameter. The cells are held firmly together in these irregularly shaped bulbous aggregates.

Aerobic.

Source: Poor soils of Brie and elsewhere in France.

Habitat: Presumably widely distributed in forest and manured soils

A similar culture called Nutresocyates BA. was isolated from activated sludge by H. Winogradsky (Compt rend Acad Sci., Paris, 200, 1935, 1888; Ann. Inst. Pasteur, 58, 1937, 326). It produced compact, bulbous, dented cyst-like aggregates of cells having a yellow color. The colonies produced clear zones on silica cel coated with CaCO. These evata were composed of oval or elongated coccoid cells imbedded in mucus and surrounded by a thickened capsule, composed of two layers. The cells become dispersed from the cysts as motile cells and form new colonies. This culture differs from N. coccoides in that the colonies have a pale reddish yellow color and the oval cells are 0.5 by 1.5 microns in size

Cultures of Natrosocystis were obtained by Rommell (Svensk, botan, Tidskrift, 26, 1932, 303) from forest soils. Kingma Bolties (Arch. f. Mikrobiol., 6, 1935, 79) obtained cultures which produced masses of cells, some of which were loose and others compact. They were not believed to be true zoogloes since no capsule or slimy substance was noted The development of true eyets by nitrifying bacteria was questioned. Winogradsky (Bull. d l'Inst. Pasteur, 55, 1935, 1974) concluded that Kingma Boltics worked with a culture of Nitrosocustis and not of Nutrosomonas as was believed.

# Genus V. Nitrosogloea H. Winogradsky.

(Compt. rend. Acad Sci., Paris, 200, 1935, 1837; Ann. Inst. Pasteur, 53, 1937, 335.)

Cells ellipsoidal or rod-shaped Embedded in slime to form zoogloca. No common membrane surrounds the cells aggregates Oudize ammonia to nitrite. From Latin. nifresus, full of soda; and Greek, gloca, glue, jelly; M L. nitrous jelly.

The type species is Nitrosogloea merismoides II. Winogradsky.

1. Nitrosogioca merismoides H. Winogradsky, (Nitrosocustus "I", H. Winogradsky, Trans, Third Intern. Cong. Soil Sci., Oxford, 1, 1935, 139; Compt. rend. Acad. Sci., Paris, 200, 1935, 1887; Ann. Inst. Pasteur, 58, 1937, 333.) From Greek, merismos, a dividing, division; eidos, form, shape; M.L. division-like.

Ellipsoidal cells: 0.5 by 1.5 microns .Oval cells or short rods forming tetrads or chains, each group with its own sheath. The groups vary in shape to produce branched chains, irregular or compact aggregates.

Colonies on silien gel: Cells encased in a pale yellow mucilage giving the colony a dull appearance Colony surface studded with little humps.

Acrobic.

Source: Activated aludge Habitat: Unknown.

2. Nitrosogloea schizobacteroides II, Winogradsky. (Nitrosocystis "II", II. Winogradsky, Trans Third Intern. Cong. Soil Ser., Oxford, 1, 1935, 139; Compt. rend. Acad. Sci., Paris, 200, 1935, 1887; Ann Inst. Pasteur, 58, 1937, 333.) From Greek, schize, to split; balterion, a small rod; eidos, form, shape; M.L. like a dividene rod.

Rods: Clongated rods or short filaments 3 to 4 microns long.

Colomes on silica pel. Flat groups of cells are produced which are united in a common sheath. The aggregates form a pseudo-tissue of interwoven filamenta suggestive of a fungus pad. The pad can be removed as a unit from the medium.

Aerobic

Source: Activated sludge.

Habitat: Unknown.

3. Nitrosogloea membranscea Winogradsky. (Nitrosocystis "III", II. Winogradsky, Trans. Third Intern. Cong. Soil Sci., Oxford, 1, 1935, 139; Compt. rend. Acad. Sci., Paris, 200, 1935, 1887; Ann. Inst Pasteur, 58, 1937, 333.) From Latin. membranaceus. of skin or membrane.

Ellipsoidal cells commonly in pairs and also solitary.

Colonies on silica gel: Appear as dull mucoid material with a pale straw color. The cells are held firmly together so that the entire colony is easily picked up with the transfer needle. No structural units within the colony.

Aerobic.

Source: Activated sludge. Habitat: Unknown.

#### Genus VI. Nitrobacter Winogradsky,

(Winogradsky, Arch. Sci. biol., St. Petershurg, 1, 1892, 127; Natromonas Orla-Jensen, Cent f. Bakt , II Abt., 22, 1909, 331; not Nitromonas Winogradsky, Ann. Inst. Past., 4, 1890, 257; Nitrobacterium Castellani and Chalmers, Manual Trop. Med., 1919, 933.)

Cells rod-shaped. Oxidize nitrite to nitrate. From Latin, nitrum, soda; M.L. nitre; and Greek baltron, a small rod.

The typo species is Nilrobacter winogradskyi Buchanan.

 Nítrobacter winogradskyi Buchanan. (Nitrobacter Winogradsky, Arch. Sci. biol., St. Petersburg, 1, 1892, 127; Bacterium nitrobacter Lehmann and Neumann, Bakt, Diag., 2nd ed., 2, 1899, 187; Bacillus nutrobacter Löhnis, Vorlesungen landw. Bakt , Berlin, 1913, 152; Buchanan, Jour. Bact., 5, 1918, 180; Nitrobacterium nitrobacter Castellani and Chalmers, Manual Trop Med., 1919, 933.) Named for S. Winogradsky, 1856-, the Russian microbiologist, who first isolated these bacteria.

Description taken from Gibbs, Soil

Sci., 8, 1919, 448.

Short, non-motile rods with gelatinous membrane, 0.6 to 0.8 by 1.0 to 1.2 microns. Does not stain readily. Cramnegative (Omelianski, Cent. f. Bakt, II Abt., 19, 1907, 263.)

Can be cultivated on media free of organic matter. Sensitive to certain organic compounds.

Washed agar colonies. In 7 to 10 days very small, light brown, circular to irregular colonies, becoming darker.

Silien gel: Colonies smaller but more dense than on washed agar.

Washed agar slant: In 7 to 10 days acanty, grayish streak.

Inorganie solution medium: After 10 days flocculent sediment. Sensitive to ammonium salts under alkaline conditions.

Nitrite is oxidized to nitrate.

Aerobie.

Strictly autotrophic.

Optimum temperature 25° to 28°C. Source: Soil.

Habitat: Presumably widely distributed in soil.

Nitrobscter agile Nelson. (Cent. f. Bakt., II Abt., 85, 1931, 287.) From Latin agile, quick, agile, motile.

Rods: 05 by 0.8 to 09 micron, occurring singly, sometimes in pairs or larger aggregates. Rapidly motile with a long, thin, polar flagellum often 7 to 10 times as long as the rod. (Non-motile culture obtained by Kingma Boltjes, Arch. f. Mikrobiol., 6, 1935, 79.) Cram-negative.

No growth in nutrient broth, nutrient agar, nutrient or plain gelatin, litmus nr plain milk, glucose or plain yeast water. or on potato.

Nitrite agar: After two weeks, produces semi-spherical, minute, nearly transparent colonies. Oxidation usually complete in 10 to 14 days.

Inorganic liquid medium containing nitrite: Produces uniformly dispersed growth.

Optimum pH 7.6 to 86 Limits of growth 6.6 to 10 0.

Temperature relations: Optimum for growth 25° to 30°G. Optimum for oxidatinn 28°C. No oxidation at 37°C. Thermal death point 60°C. for five minutes.

Strictly autotrophic.

Acrobic.

Source: Isolated from greenhouse soils and from sewage effluents in Madison. Wisconsin.

Habitat: Presumably widely distributed in soil.

Genus VII. Nitrocystis H. Winogradsky.

(Trans Third Intern. Cong Soil Sci , Oxford, 1, 1935, 139; Natrogloca H. Winogradsky, Comp. rend. Acad Sci , Paris, 200, 1935, 1888.)

Cells ellipsoidal or rod-shaped Embedded in slime and united into compact zoo. glocal aggregates. Oxidize nitrite in nitrate. From Latin, nitrum, soda: M.L. nitre; and Greck, kustis, bladder, M.L. nitric cyst.

The type species is Natrocystis surcinoides.

1. Nitrocystla sarcinoides H. Winogradsky. (Nitrocustis B. A., Winogradsky, H., Compt. rend Acad. Sci., Paris, 200, 1935, 1883; Nitrocystis "I" and "II", Winogradsky, II, Trans. Third Intern. Cong. Soil Sci. Oxford, 1, 1935, 139; Ann. Inst. Pasteur, 58, 1937, 336.) From Latin, sarcina, a packet; M.L. Sarcina, a genus: Greek, cidos, form, M.L. Sarcina-like.

Rods: Small rods 0 5 by 1.0 mieron Cells ellipsoidal or wedge-shaped and grouped in sarcina-like packets

Colonies on silica gel : On the surface of gel coated with kaolin the colonies appear as small raised amber warts The colonles grow up to 5 mm in diameter The colonies are viscous and sticky when young and they become brown with age, shrink, and look like scales and become hard like grains of sand. Each colony is enveloped in several layers of a thick slime which holds the cells together so that the entire colony can be removed with a transfer needle.

Aerobie. Source: Activated sludge.

Hsbitat: Unknown.

2. Nitrocystis micropunctata H. Winogradsky. (Nitrocystis "III", Winogradsky, H., Trans Third Intern. Gong. Soil Sei., Oxford, 1, 1935, 139; Netrogloca micropunctata Winogradsky, H., Compt. rend. Acad. Sci., Paris, 200, 1935, 1888; Ann. Inst. Pasteur, 58, 1937, 326.) From Greek, mikros, small, little; and Latin, punctatus, spotted: M L. with small spots.

Cells are ellipsoidal reds about 0.5 micron in diameter which stain poorly except at the ends Encased in a viscous shme.

Colonies on silica gel Like N. sarcincides except that the rolonies are more clear and they have a more plastic consistency. The cells are not held together by the slime in the colony as with N. sarcinoides. 'The capsule is more readi'y differentiated in old colonies

Aerobic.

Source: Activated sludge. Habitat: Unknown.

Appendix: The following have been placed in the Tribe Nitrobactericae, sometimes incorrectly so:

Bactoderma alba Winogradsky. (Ann.

Inst. Pasteur, 50, 1933, 414) From soil.
This is the typo species of genus Bacto-derma Winogradsky.

Bactoderma rosea Winogradsky (loc. cit., p. 415). Isolated from soil.

Bacterum nitrificans Chester. (Nitratbildner aus Northeim, Burri and Stutzer, Cent. f. Bakt , I I Abt., f. 1895, 735; Chester, Ann. Rept. Del. Col Agr. Exp. Sta., g, 1897, 94, Bacillus nitrificans Chester Man Determ Bact., 1901, 239, Achromobacter nitrificans Bergey et al., Manual, 1st ed., 1923, 137.) From soil. Description of this organism was shown by Winogradsky (Cent f. Bakt., II Abt., g, 1896, 415 and 449) to have been based on impure cultures.

Microderma minutissima Winogradsky. From soil. This is the type species of

genus Microderma Winogradsky.

Microderma vacuolala Winogradsky

(loc. cit.). Isolated from soil
Ni'rosobacillus thermophilus Campbell.

Seo Bacillus appendix.

Nitrobacter flavum Sack. (Cent. f. Bakt., II Abt., 62, 1924, 20) Isolated from garden earth Seo description,

Manual, 5th ed., 1939, 74. Heterotrophic and does not belong here (Kingma Boltjes, Arch. f. Mikrobiol., 6, 1935, 83).

Nitrobacter oligotrophum Beijerinek. Folizoha Mierobiol., 3, 1914, 91; Verzamelde Geschriften van M. W. Beijerinek, 5, 1922, 190.) Isolated from soil. On cultivation this species lost its autotrophic labit and became heterotrophic. The organism was then called Nitrobacter polytrophum Beijerinek.

Nitrobacter opacum Sack (loc. cit. p. 21). Source and relationships as above. See Manual, 5th ed., 1939, 75.

Nitrobacter punctatum Sack (loc. cit., p. 20). Source and relationships as above. See Manual, 5th ed., 1939, 75.

Natrobacter roseo-album Sack (loc. cit., p. 17; Serratia roseo-alba Bergoy et al., Manual, 3rd ed., 1930, 125.) Source and relationships as above. See description, Manual, 5th ed., 1939, 74.

Nitrosomonas groningensis Sack. (Cent. I. Bakt., II Abt., 64, 1925, 34.) Source and relationships as above. Sca description, Manual, 5th ed., 1939, 77.

#### TRIBE II. HYDNOOENOMONADEAE PRIBRAM.

(Jour. Bact., 18, 1929, 370.)

Short rods, non-motile or with lophotrichous flagells. Organisms capabla of deriving energy from oxidation of hydrogen. They probably grow well on organic media without hydrogen, although this has not been shown to grow true for all species.

# Genus I. Hydrogenomonas Orla-Jensen.\*

(Cent. f. Bakt., II Abt., 22, 1909, 311.)

As the only genus of the tribe, its definition is identical with the definition of the tribe. From Greek hydör, water; genos, producing and monas, a unit.

The type species is Hydrogenomonas pantotropha (Kaserer) Orla-Jensen.

<sup>•</sup> This group of bacteria is characterized by the ability to grow in substrates containing no organic matter and to utilize elemental hydrogen as the source of energy for growth. Under these conditions CO<sub>2</sub> is used as the source of carbon. Bacteria with similar physological characteristics but differing in morphology are placed in the genera Bacterium, Bacillus and Clostridum. Although other bacteria and even certain algae have enzyme systems which can activate hydrogen and reduce CO<sub>2</sub> in the process, there is no evidence that these organisms are able to grow in inorganic media

# Ken to the species of genus Hydrogenomonas.

- A. Not sensitive to high Oc concentrations Growth in solution media under autotrophic conditions characterized by turbidity without pellicle formation.
- 1 Hudrogenomonas vantotropha. B. Sensitive to high O2 concentrations Growth in solution media under autotrophic conditions characterized by pelliele adhering to walls of container.
- 2 Hudrogenomonas vitrea C. Sensitive to high O. concentrations Growth in solution media under autotrophic conditions without pellicle formation.
  - 3 Hydrogenomonas flava.
- Hydrogenomonas pantotropha (Kaserer) Orla-Jonson (Bacellus panintrophus Kaserer, Cent f Bakt, II Abt , 16, 1906, 688, Orla-Jensen, Cent f. Boht., II Abt., 22, 1909, 311 } From Greek pantos, everything and trophos, feeds on; M.L. omnivorous

Rods: 04 to 05 by 12 to 15 merons with rounded ends Occur singly, in pairs, and in chains, Encapsulated Actively motile by means of a single long polar flagellum, Gram stain not recorded. Bipolar staining in old cultures

Inorganic solution: When cultivated under an atmosphere of O1, CO2 and He, the liquid becomes turbed without pellicle formation

Inorganic solid media. When cultivated under an atmosphere of O., CO, and H., the colonies are yellow and slimy, and the agar plates have an odor resembling hot scapy water.

Gelatin colonies: Yellow, rarely concentrically ringed or greenish Gelatin stab. Growth only at surface

As a rule no liquefaction. Agar colonies Same as on gelatin,

greenish, often slimy. Broth: Turbid, somewhat slumy, and

occasional pellicle Milk: No coagulation. A yellow pellicle forms. Medium becomes slimy and assumes a dirty flesh color.

Potato: Moist, yellow, glistening. Indole is not formed. Hydrogen sulfide is not formed. Nitrite is not produced from mirate Does not not on earbohydrates.

Acrobic.

Optimum temperature 28° to 30°C. Facultative autotroph

Distinctive characters Develops autotrophically in inorganic medium under an atmosphere of H2, O2 and CO. Ovidezes hydrogen to nater and uses CO, as the source of carbon for growth.

Source, Isolated from soil near Vienna, Habitat, Probably widely distributed m soil.

2 Hydrogenomonas vitrea Nikleuski. (Jahrb. f wissensch, Botanik, 48, 1910. 113) From Latin pitreus, of glass, transparent.

Rods 2.0 microns in length, cells adherme to each other as by shme Motility not observed

Acar colonies on inorganic medium in presence of IIs, Os and CO. Delicate, transparent, with slight fluorescence, and vellow center. Surface folded. Do not develop readily beneath the surface of

Agar streak on morganic substrate. Same as agar colonies except that growth sa apprading.

Inorganic liquid medium in presence of Hr. Or and COr. Pellicle, adherent to wall of tube. Good development when there is from 2 to 8 per cent oxygen in the ras At lugher G, concentrations good growth occurs only in association

with H. flare or other bacteria. Oxidizes hydrogen to nater.

Microserophilie, growing in an atmosphere of low oxygen tension, not exceeding 8 per cent.

l'acultative autotroph.

Distinctive characters: Grows in substrates containing no organic matter and

produces a pellicle.

Source: Isolated from mud, garden soil, pasture lond, vegetable mold, and peat.

Habitat: Presumably widely distributed in soil.

 Hydrogenomonas flava Niklewski. (Jahrb. f. wissenseh. Botanik., 48, 1910, 113; emend. Kluyver and Manten, Antonie v. Leuwenhoek, 8, 1942, 71.)
 From Latin flavus, yellow.

Rods: 1.5 microns in length. Motility by polar flagella. Gram-negative.

Agar colonies on inorgonic medium in presence of H<sub>1</sub>, O<sub>1</sub> and CO<sub>2</sub>: Small, smooth, yellow, shining, adhering to medium. Develop well below surface of medium, but growth is paler.

Golatin not liquefied.

Inorgonic liquid medium in presence of H<sub>2</sub>, O<sub>2</sub>, ond CO<sub>2</sub>: No pelliclo formation. Good development when there is from 2 to 8 per cent oxygen in the gos At bigher O<sub>2</sub> concentrations good growth occurs

only in association with H. vitrea or other bacteria.

Oxidizes bydrogen to water.

Mieroaeropbilic, growing in an atmosphere of low oxygen tension, not exceeding 8 per cent.

Facultative nutotroph.

Distinctive characters: Found singly on slides whereas the rod-shaped cells of Hydrogenomonas vitrea tend to cling together in masses. Colonics on agar onaque, not transparent.

Source: Same as H. vitrea.

Hobitat: Presumably widely distributed in soil.

Appendix: Iocompletely described species are found in the literature as follows:

Hydrogenomonas agilis Niklowski. (Jubliaumsschrift f. Prof. E. Godlowski. Kosmos, Lemberg, 1913; Sco Cent. f. Bakt., H Abt., 40, 1914, 430.) From soil.

Hydrogenomonas minor Niklewski. (Jubliaumsschrift f. Prof. E. Godlewski. Kosmos, Lemberg, 1913; Sco Cent. f. Bakt., II Abt., 40, 1914, 431.) From soil.

TRIDE III. THIOBACHLEAE BERGEY, DREED AND MUDRAY.

(Preprint, Manual, 5th ed., Oct., 1938, v.)

Organisms capable of deriving their energy from oxidation of sulfur or sulfur compounds. Most species do not grow on organic media.

# Genus I. Thiobactilus Beijerinck.

(Beijerinek, Cent. f. Bakt., II Abt., 11, 1904, 593; Suljomonas Orla-Jensen, Cent. f. Bakt., II Abt., 22, 1909, 314; In Abt. elilis, Sulphur bacteria, London, 1932, 130; Thiobacterium Lehmann and Neumana, Bakt. Diag., 7 Aufl., 2, 1927, 517; not Thiobacterium Janke, Allgemeine Teeb. Mikrobiol., 1, 1924, 68, Leipzig)

Small Gram-negative, rod-shapedeells. Non-motile or motile by means of a single polar Osgellum Derive their energy from the ordation of incompletely ordidzed sulfur compounds, principally from elemental sulfur and thiosulfate but in some cases also from sulfide, sulfite, and polythionates. The principal product of oxidation is sulfate, but sulfur is sometimes formed. They grow under acid or alkalme conditions and derive their carbon from earbon dioxide or from blearbonates in solution; some are obligate and some facultative autotrophie. One species is facultative anaerobic. From Greek heiron, sulfur and Latin baceflus, a small rod.

The type species is Thiobacillus thioparus Beijerinck.

# Key to the species of genus Thlobsellius.

- I. Aerobic.
  - A. Strictly autotrophic.
    - 1. Optimum reaction for growth close to neutrality.
      - 1. Thiobacillus thioparus.
    - 2 Optimum reaction for growth pH 2.0 to 3.5.
      2. Theobacillus thiograidans.
  - B. Facultative sutotrophic.
- 3. Thiobacillus novellus.
  4. Thiobacillus coproluicus.
- II. Anaerobic in presence of natrate.
- Thiobacillus denurificans.
- Thiobacillus thioparus Beijerinek (Cent. f. Bakt., II Abt., 11, 1004, 593; Nathanson, Mitt. Zool Station Neapel, 18, 1902, 655; Sulfomenas thioparus Orla-Jensen, Cent. f. Bakt., II Abt., 22, 1902, 326). From Greek theion, sulfur end paro, to make

Thin, short rods, 0 5 by 1 to 3 0 macrons. Motile (non-motile culture reported See Starkey, Soil Sci., 39, 1935, 197.) Gram-negative.

Thiosulfate medium (liquid). Pellicle consisting of cells and free sulfur.

Thiosulfate agar. Colonies small, circular, whitish yellow due to precipitated sulfur.

Optimum reaction: Close to neutrality. Strictly autotrophic. Derives its eaergy by the oxidation of thiosulfate to sulfate and sulfur; also oxidizes sulfur to

sulfate.

Source: Sca water, river water, mud, sewage, and soil.

Habitat: Presumably widely distributed.

 Tbiobacillus tbioozidans Wakaman and Joffe. (Jour. Bact., 7, 1922, 239, Sulfomons thoozidans Wakaman, Jour. Bact., 7, 1922, 616; Thiobacterium thioozydans Lehmann and Neumann, Bakt Diag., 7 Aud., 2, 1927, 517) From Greek theion, sulfur and M.L. to oxidire.

Short rods: 0 5 by 10 micron with rounded ends. Occur singly, in pairs, or in chains. Motile by means of a single polar flagellum. Gram-pegative (Starkey, Soil Sci., 59, 1935, 210).

Thiosulfate agar: Scant growth. Nearly transparent colomes.

Sulfur medium (liquid): Uniform turhidity. No sediment or surface growth. Medium becoroes very acid (below pH 10).

Thiosulfate medium (liquid): Uniform turbidity. Medium becomes acid and sulfur is precipitated.

Nitrogen sources. Utilizes ammonia nitrogen but not nitrate nitrogen which is toxic. Asparagin, ures and peptone not utilized.

Temperature relations. Optimum 28° to 30°C. Slow growth at 18° and 37°C. Death occurs at 55° to 60°C.

Optimum reaction; pH 20-3.5. (Limiting reactions, pH 6.0 to less than pH 6.5.)

Strictly autotrophic, deriving its energy from the oxidation of elementary sulfur and thiosulfate, oxidizing these to sulfurie scid. It utilizes the CO<sub>2</sub> of the atmosphere as a source of carbon.

Strictly aerobic.

Distinctive characters: This species produces more seid, from ovidation of sulfur, and continues to live in a more acid medium, than any other living organism yet reported, the hydrogen-ion concentration of the medium increasing to a pH 0 6 and less.

Source: Isolated from composts of soil, sulfur, and rock phosphate and soils containing incompletely oxidized sulfur compounds.

Habitat: Soil.

3. Thiobacillus novellus Starkey. (Jour. Bact., 28, 1934, 365; Jour. Gen. Physiol., 18, 1935, 325; Soil Sci., 39, 1935, 207, 210.) From Latin novellus, new.

Short rods or ellipsoidal cells: 0.4 to 08 by 06 to 1.8 microns. Non-motile.

Gram-negative.

Gelatin stab. Mucoid growth at point of inoculation Sub-surface growth meager, Slow liquefaction

Agar plate: Growth slow, colorless, moist, raised, circular, 1 mm in diameter. Deep colonies tiny, lens-shaped.

Thiosulfate agar plate: Growth slow, becoming white from precipitated sulfur. Surface colonies small, circular, moist. Crystals of CaSO, appear throughout the agar.

Agar slant: Growth fairly abundant, soft, somewhat ropy, raised, shining, moderately spreading; whitish in reflected light, brownish opalescence in transmitted light.

Thiosulfate agar slant: Growth very thin, practically colorless. No sub-surface growth Sulfur usually precipitated as winte frosty film on the surface.

as white frosty him on the surface.

Agar stab. White to cream-colored growth confined close to point of inoculation. Penetrates to bottom of tube.

Thiosulfate agar stab. No appreciable

surface growth

Broth Slightly turbid. Gelatinous pellicle Forms long streamer-like network extending from surface to the

bottom Some sediment.

Thiosulfate solution medium: Uniform turbidity. No pellicle Whitish sediment with than incomplete membrane on the bottom of the flask Reaction acid in a few days, changes pH 78 to 58 with decomposition of a small quantity of throsulfate.

Sulfur solution medium of slightly alkaline reaction No growth

Potato slant Growth limited, creamcolored, moist, shining, slightly brown Litmus milk. Slow development of

slight alkalimity. Facultative autotrophic. Optimum reaction: Close to neutrality (limiting reactions pH 5.0 to 90).

Aerobic.

Distinctive characters: Oxidizes thiosulfate to sulfate and sulfuric acid. Does not exidize free sulfur.

Source: Isolated from soils.

Habitat: Soils.

 Thiobacillus coprolliticus Lipman and McLees. (Soil Sci., 50, 1940, 432.)
 Latinized form of the Englishword coprolite, fossil dung.

Long thin rods: 01 to 02 by 6 to 8 (may measure 3 to 40) microns. Straight, S-shaped, and curved cells. Mottle by means of a single polar flagellum

Peptone soil extract agar: Slight growth

Nutrient solution. Little or no growth. Thosulfate agar: Slow development. Produces small watery colonies raised above the agar surface. Colonies have been noted which were white from precipitated sulfur.

Thiosulfate solution: Thiosulfate is oxidized. Lattle or no turbidity. No pellicle. No sediment. Change in reaction from pH 76 to 61.

Sulfur medium: Sulfur is oxidized.

No turbidity.

Facultative autotrophic.

Aerobic.

Distinctive characters: Develops in inorgane media and oxidizes thiosulfate and sulfur to sulfate. Media with slightly alkaline reactions most favorable for growth.

Source: Coprolite rock material from Triassic period (Arizona)

Habitat · Unknown

 Thlobacillus denitrificans Beijernuck. (Cent. f. Bakt., 11 Abt., 11, 1904, 597; Sulfomona denitrificans Orha-Jensen, Cent. f. Bakt., 11 Abt., 22, 1909, 314.)
 From Latin, de, from; and M.L. nitrifico, to nitrify

Short reds, 0.5 by 1 to 3.0 microns long Motile by means of a single polar flagellum (Tjulpanova-Mossevitch, Arch. d. Sci. Biol., U.S.S.R., 80, 1930, 293).

Inorganic liquid medium. Growth with production of gas, predominantly nitrogen.

Thiosulfate agar medium: Colonies thin, clear, or weakly opalescent.

Optimum reaction: Neutral or slightly alkaline.

Autotrophie, utilizing carbon fmm CO<sub>2</sub>, carbonates and brearbonates Considered to be strictly autotrophic by Lieske (Ber. d. deutsch. botan. Gesell., 29, 1912, 12.) and facultative by Tuptanova-Mossevitch (Ioc. cit.). Beyerinck stated (Kon. Akad. v. Wetenschappen Amsterdam, 42, 1920, 899) that whereas the organism developed intitally in an inorganic medium, it lost the autotrophic habit by cultivation in an organic medium.

Facultative anaerobic or even microacrophilic. Can live in the absence of free O<sub>2</sub> in the presence of nitrate.

Distinctive characters Oxidites throsulfate to sulfate under anaembie conditions using nitrate as the hydrogen acceptor which is reduced to N<sub>2</sub>. Also oxidizes sulfade, elemental sulfur, and dithionate:

Habitat: Cansl and river water, salt water, soil, peat, composts and mud.

Appendix: The following species have been placed in *Thiobacillus* or are regarded as belonging to the genus:

Thiobacellus concreticorus Parker. (Austral, Jour. Exper. Biol. and Med. Sci., 23, 1915, 81) From corroded concrete sewers. Similar to or identical with Thiobacillus thiooxidans Waksman and Joffe.

Thiobacillus crenatus Emoto. (Proc. Imp. Acad. Tokyo, 5, 1929, 149.) Isolated Imm mud of bot springs in Japan See description, Manual, 5th ed., 1939, 81. Almost identical with Thiobacillus thiooxidans Waksman and Joffe.

Thiobacullus lobatus Emoto (loc. cit., p 148). Source and relationships as above. See description, Manual, 5th ed., 1939. 83.

Thiobacillus thermitanus Emoto (Bot. Msg. Tokyo, 42, 1928, 422.) Source and relationships as above. See description, Manual, 5th ed., 1939, 83.

Thiobacillus trautweinti Bergey et al. See Flavobacterium appendix. Thiobacillus umbonatus Emoto (loc.

Thiobarilus umbonatus Emoto (loc. cut., p. 150). Source and relationships as above. See description, Manual, 5th ed., 1939, 84.

Thebacterum beyerinckii Issatchenko and Salimonskaja (Zur Morphologie u. Physiol. der Theonsturebakterien (Russian with German abstract), Lyicsatia Gesud. Gidmbiol. Inst., No 21, 1923, 61.) From salt seas in Russia. Similar to or identical with Thebactillus théoperus Beierinck.

Thiobacterium beyerinch is var. jacobcents Issatschenko and Salimonskaja (loc. cet.). Variety of previously mentioned species.

Thebacterium nathansons Issatchenko and Salimonskaja (loc cit.). From salt seas in Russia. Similar to or identical with Thiobacillus thioparus Belgenack.

# FAMILY II. PSEUDOMONADACEAE WINSLOW ET AL.

(Jour. Bact., 2, 1917, 555.)

Cells without endospores, clongate rods, straight or more or less spirally curved. One genus (Mycoplana) has branched cells. Usually motile by polar flagella which are either single or in small or large tufts. A few species are non-motile. Gram-negative (a few doubtful Gram-positive tests are recorded in Pseudomonas). Grow well and fairly rapidly on the surface of ordinary culture media excepting Methanomona and some vibrios that attack cellulose. They are preferably aerobic, only certain vibrios including Desulfonibrio being anaerobic. Either water or soil forms, or plant or animal pathogens.

Key to the tribes of family Pseudomonadaceae,

Straight rods.

Tribe I. Pseudomonadeae, p. 82.

2. Cells more or less spirally curved.

Tribe II. Spirilleae, p. 192.

THIBE I. PSEUBOMONABEAE KLUYVER AND VAN NIEL.

(Cent. f. Bakt., II Abt., 94, 1936, 397.)

This tribe includes all of the straight and branching rods of the family.

Key to the genera of tribe Pseudomoaadeae.

- I. Soil and water bacteria. Few animal and many plant pathogens. Usually produce a water-soluble pigment which diffuses through the medium as a bluisb-green or yellowish-green pigment.
  - Genus I. Pseudomonas, p. 82.
- Cells usually monotrichous with yellow non-water-soluble pigment. Mostly
  plant pathogens causing necrosis.

Genus II. Xanlhomonas, p. 150.

III. Soil bacteria which oxidize methane.

Genus III.

Genus III. Methanomonas, p. 179.

IV. Bacteria which oxidize alcohol to acctic acid.

Genus IV. Acctobacter, p. 179.

V. Soil and water bacteria known to attack protamines.

Genus V. Protaminobacter, p. 189.

VI. Soil bacteria with branching cells. Capable of using aromatic compounds, as phenol, etc., as a source of energy.

Genus VI. Mycoplana, p. 191.

# Genus I. Pseudomonas Migula.\*

(Migula Arb. bakt. Inst. Karlsruhe, 1, 1894, 237; Bacterium Ehrenberg emend. Cohn, Beitr z Biol d Pflancen, 1, 14eft 1, 1572, 167; Bactrillum Fischer, Jahrb f. wissensch Bot, 27, 1895, 139, Bactrinium Fischer, ibid., 413; Arthrobactrillum Fischer, ibid., 139; Arthrobactrillum Fischer, ibid., 139; Bactrilium Kendall, Public Health, 28, 1902, 484; Bactrillum Kendall, ibid; Bacterium Ehrenberg emend. Smith, Bacteria

<sup>\*</sup> Revused for the 5th ed. of the Manual by Prof. D. H. Bergey, Philadelphia, Pennylvania, 1937. Further revision for the 6th ed by Prof. R. S. Breed, New York State Experiment Station, Geneva, New York, with incorporation of the plant pathogenic species by Prof. Walter H. Burkholder, Cornell University, 1thaca, New York, April, 1943.

in Relation to Plant Disease, 1, 1905, 171; Denstromonas Orla-Jensen, Cent. f. Bakt., Il Abt., 22, 1909, 314; Liquidomonas Orla-Jenson, abid., 332; Lamprella Enderlein, Sitzber, Gesell, naturf. Freunde, Berlin, 1917, 317; Fluoromonas Orla-Jensen, Jour Bact., 6, 1921, 271 )

Cells monotrichous, lophotrichous or non-motile If pigments are produced, they are of greenish lue, fluorescent, and water-soluble. Gram-negative except Nos. 88, 122 and 128. Frequently ferment glucose, sometimes with the formation of visible gas. Inactive in the fermentation of lactose. Nitrates are frequently reduced either to nitrates or ammonia, or to free nitrogen. Some species solit fat and attack hydrocarbons. Soil, water, and plant pathogens; very few animal pathogens. Certain salt water species (Nos 59-61) some of which live in heavy brine are temporarily retained in this genus although they produce non-water-soluble pigments or phosphorescence. From Gr pseudes, false, monos, a unit; M. L. monad,

The type species is Pseudomonas aeruginosa (Schroeter) Migula.

#### Ken to the species of genus Pseudomonas.

- I. Soil and fresh water forms with a few that are pathogenic on cold or warm blooded animals.
  - Green fluorescent pigment produced.
  - a. Gelatin liquefied.
    - b. Polar flagellate.
      - c. Grow readily at 37°C. Usually bluish-green.
        - 1 Pseudomonas aeruginosa.
        - 2 Pseudomonas saegers
        - ce. Grow poorly or not at all at 37°C.
          - d. Milk not coagulated becoming alkaline e. Soil and water organisms. Not known to
            - digest cellulose.
              - 3 Pseudomonas fluorescens.
                - 4. Pseudomonas viscosa
              - 5. Pseudomonas fairmountensis.
              - 6. Pseudomonas urcae.
              - 7 Pseudomonas pavonacea.
              - ee. Soil forms that attack cellulose.

            - 8 Pseudomonas effusa.
            - eee Pathogenic for hzards.
            - 9. Pseudomonas reptiluorous.
          - dd. Milk unchanged becoming blue in association with lactic acid bacteria.
            - 10. Pseudomonas syncyanea.
          - ddd. Milk coagulated.
            - 11. Pseudomonas schuylkilliensis 12. Pseudomonas chlororaphis.

              - 13 Pseudomonas myzogenes.
              - 14. Pseudomonas septica
          - dddd, Soil form. Action on milk not recorded 15. Pzeudomonas borcopolis.

See Tobie, Jour. Boct., 49, 1945, 459 for a discussion of the nature of these pigments.

I. Die Polyangiden, Geb. Borntraeger, Leipzig, 1924, 86.)

Etymology: Greek megalos, large; sporos, seed, spore; large spored.

Swarm stage (pseudoplasmodium): Not described.

Fruiting bodies: About 80 to 160 microns wide, rounded, cushion-shaped, dark flesh color. Spores 2 microns

Source and habitat : Jahn (loc. cit.), on stag dung near Berlin.

Illustrations: Jahn (loc. cit.) Fig. Y, i to k, p. 87.

Chondrococcus macrosporus Krzemioniowski, (Acta Soc. Bot. Poloniac, 4, 1926).
 According to Krzemieniewski, not to be confused with Zukal's species, Myzococcus macrosporus (Ber. d deutsch Bot. Gesellsch., 18, 1897, 542.)

Etymology: Greek makros, long, large; spores, seed, spore; large-spored.

Swarm stage (pseudoplasmodium): Not described

Fruiting bodies: Much like Chondrococcus coralloides, differing in color and m size of spores. Spores 16 to 2.0 microns. Fruiting body yellow at light brown color, with long branches.

Source and habitat. Krzemieniewski (loc. cit.), found it first on leaves, later isolated from soil on rabbit dune.

Illustrations: Krzemiemewski (loc.

5 Chondrococcus blasticus Beebe. (Iowa State Col. Jour. Sci., 18, 1941, 310.)

Etymology Greek blastikos, budding. Fruiting body. Primary: Spherical to subspherical, usually sessile but occasionally with a short stalk or foot; pale pink to bright salmon pink; 300 to 600 microns in diameter. No outer wall or limiting membrane evident. Develops on sterilured rabbit thing in from 3 to 6 days at room temperature. Secondary Arising as bud-like growth from the primary fruiting body. Develops into irregularly shaped, finger, corai- or bud-like protuberance. Seldom branched; occasionally stalked but usually sessile on

primary fruiting body until latter is utilized in formation of several secondary fruiting bodies. Deep pink to salmon pink in color. Variable in size and shape; 50 to 150 by 75 to 225 microns. No outer wall or limiting membrane evident.

Spores: Spherical, thick-walled, highly refractile; 1.2 to 1.4 microns in diameter Held together in the fruiting body by the mass of slime.

Vegetative cells: Long, slender, flevible rods, straight or curved to bent, ends rounded to slightly tapered, Gramnegative. 0.5 to 0.0 by 3 0 to 5 0 microns. Usually found in groups of 2 to 12 lying parallel on the surface of the slimy colony, the group moving as a unit. Motile by a crawling or creeping motion, on flacella.

Vegetative colony: Thin, colorless, transparent at margin; surface broken by many small ridges or veins. Center smooth, slightly thicker, often showing pale pink color. Fruiting bodies first form at or near center, later distributed irregularly on other parts of colony. Margin composed of active vegetative

cells.
Physiology: Good growth on mineral sait agar to which has been added such complex carbohydrates as dulcitol, inuline cellulose, reprecipitated cellulose or starch; starch hydrolyzed, cellulose not destroyed appreciably. As a utilize agar as both C and N sources. Best growthen suspensions of killed b derial cells in agar Growth inhibited partially or catterly by araburose, manness and

maltose.
Source: Goat dung and soil, Ames,

Habitat: Soil. Decomposes organic matter, especially bacterial cells in dung.

Illustrations: Beche (loc. cit.) Pl. II, Figs. 5-6, pl. IV, Fig. 18.

6 Chondrococcus cerebriformis (Kofler) Jahn. (Myzococcus cerebriformis Kofler, Sitzher. d. kais. Akad. Wiss., Wien. Math. Nat. Klasse, 122

- Cysts 60 to 170 microns, without definite envelope, in swollen brain-like arrangement
- 6 Chandrococcus cerebriformis.
  2. Cysts 30 to 35 microns, numerous, and embedded in a thick slime envelope
  11 Chandrococcus coralloides var.

#### 11. Parasitic on fish.

1 Chondrococcus coralloides (Thaxter) Jahn (Myzococcus coralloides Thaxter, Ikot. Gaz., 17, 1892, 401; Myzococcus digitatus Quehl, Cent f Bakt., Il Mot., 16, 1900, 18 (pro parte); Myzococcus claratus Quehl, ibid; Myzococcus polyegatus Koller, Statzberg, d. kais Was, Wien Mat. Nat. Klasse, 122 Abt., 1013, 865 (pro parte); Myzococcus ezuguus Koller, ibid, 867 (pro parte); Chondrocucus polyegitus Krzenienienski, Act See Bot Polonia, 4, 1929, 46)

Etymology Greek kerallion, coral,

Swarm stage (pseudoplasmodium) Rod masses pale pinkish, thin, rods slender, curved 4 to 7 by 0.4 microns leadily cultivated on lichens and on rotato agar

Fruiting bodies: Very variable in shape, usually with rounded coral-like processes, recumbent or upright, sometimes with finger like outgroaths or numded constrictions, usually small, about 50 microns in disameter, protubermores 20 to 30 microns wide, light rose to flesh color. Spores 1 to 1.2 microns Jahn concludes that the species eggregated by Qiebl and by Koffer are of varietal rank only Kreinheinewski (1925) regards Chondroceuse polygriyus (Koffer) Kriemieniewski as a distinct species.

Source and labitat. Thatter (1822), uncommon in America, on lichers. Very common in Europe, Jahn (1921), relatively common in Europe, Jahn (1921), relatively common on durag frabbit, hare, hores, deer, old bark and old lichers Goat dury from Lapland and Raly. Riofer (1913), dung of fedd mice, horse, hares, gusts, two and deer. Krezerienies-ski (1927), common in Polath soil.

# polycystus. 7 Chondrococcus columnaris

Hustrations Thanter (1892, loc. cit.) Pl. 21, Figs. 29-33. Queld (1996, loc. cit.) Pl. 1, Figs. 1 and 9. Koffer (1913, loc. cit.) Pl. 1, Figs. 4, Pl. 2, Fig. 9. Kracmeniewski (1995, loc. cit.) Pl. 11, Figs. 15-18. Jahn (1921, loc. cit.) Fig. Y, p. 87.

- in Chondrococcus corralloides var. claratus varies from Chondrococcus coraltoides in having fruiting bodies simple or branched rather than constricted or jointed.
- 1b. Chandrococcus correlloides var. polycystus varies from Chandrococcus corolloides, in having its fruiting bodies simple swellings or "eyst heaps" rather than branched, and in bring recumbent rather than erect
- Chondrococcus cirrhosus (Thatter)
  Jahn. (Myzoroccus cirrhosus Thatter,
  Bot Gar, 25, 1807, 409, Jahn, Beltrigo
  zur botaniechen Protistologie I. Die
  Polyangiden, Geb Borntraeger, Leipzig,
  1924, 200)

Etymology Modern Latin from Greek

Swarm stage (pseudoplasmodium); Rods 0.8 by 2 to 5 micross

Fruiting bodies Dongate, upright, thickened below, stender above, extended to a rounded point, 50 to 100 microns long, 20 microns in diameter at leve, light red to fiesh-colored. Fromes about 1 micron.

to fiesh-colored Spores about 1 micron.

Source and habitat: Tharter (loc. cit.),
once only on grouse dung, Mass.

Illustrations Thanter (for cit ) F1.

3 Chondrococcus megalosporus Jahn. (Reiträge zur botanischen Protistologie.

Etymology: Greek diskos, a quoit, discus; Latin formis, shape.

Swarm stage (pseudoplasmodium): Rods 0.5 to 0.6 by 2 to 3 microns.

Fruiting bodies: Cysts disk-shaped. crowded, sessile, attached by a more or less ragged scar-like insertion, or in masses. Cysts yellowish when young, when old dark orange vellow, about 35 by 10 microns. Cyst wall distinct, thin, becoming very slightly wrinkled. Spores irregularly spherical, embedded in vis-Per. 14 for and in the sine street

(1927, loc. cit.), rare in Polish soils.

Illustrations · Thaxter (loc. cit.) Pl. 27, Figs. 19-21. Krzemieniewski Acta Soc. Bot. Poloniae, 4, 1926, Pl. II. Figs. 21-22

2. Angiococcus cellulosum Mishustin. (Microbiology, Moscow, 7, 1938, 427.)

Etymology: Modern Latin cellulosum, cellulose.

Fruiting body: Regularly rounded (less frequently extended or angular), 20 to 150 microns in diameter; yellow or pink in color, to drabbish when old. Eccysted cells surrounded by a colorless cyst wall

or envelope. Usually 1 to 3 short stalks or cystophores up to 10 microns high. Within outer wall are numerous cysts containing resting cells (spores). Cysts have regularly rounded form; unpigmented to yellow; 5 to 15 microns in diameter, average 6 microns, Number of cysts in fruiting body increases with age.

Spores: Cocci (term used is shortened rods) combined into globular aggregations easily broken up. Size not given.

Vegetative cells: 0.4 to 0.5 by 15 to 2.0 microns. Cell contents pigmented gray, and of indefinite outline (?).

Vegetative colooy: Fairly rapid growth on cellulose with silica gel. Colony has a yellowish east. Reaches diameter of 1 5 to 2.0 cm after 6 days with center vellowish-pink and margin tinged light pink. Surface moist. Fruiting bodies more numerous at center, but distributed over entire area. Fruiting bodies do not noticeably protrude above the surface of the colony.

Physiology: Cellulose attacked but not completely destroyed. Lower fibers remajo intact, but on treatment with hot soda solution they fall spart

Habitat : Soils.

Genus IV. Sporocytophaga Stanier.

(Jour. Bact., 40, 1940, 629.)

Diagnosis: Spherical or ellipsoidal microcysts formed loosely in masses of slime among the vegetative cells. Fruiting bodies absect.

Etymology: Greek sporos seed, spore; kytos hollow place, cell and phagein to eat. The type species is Sporocytophaga myzococcoides (Krzemieniewska) Stanier.

Key to the species of genus Sporocytophaga.

I. Microcysts spherical.

A. Does not utilize starch.

1 Sporocytophaga myzococcoides.

B. Utilizes starch.

2. Sporocytophaga congregata.

II. Microcysts ellipsoidal.

3. Sporocytophaga ellipsospora.

Abt., 1913, 866; Jahn, Beiträge zur botanischen Protistologie. I. Die Polyangiden, Geb. Borntraeger, Leipzig, 1921, 86.)

Etymology. Latin cerebrum, broin; formis, shape.

Swarm stage (pseudoplasmodium): Rods 4 to 12 microns.

Fruiting bodies: About 1 mm long, clumped masses with swollen upper surface, brain-like, violet rose, often lead-gray Cysts 100 to 170 microns, without sime envelope Spores 1.1 to 16 microns Jahn (loc. cit.) suggests that this may be Archangium pephyra

Source and habitat : Koffer (loc cit ), on hare dung in the vicinity of Vienna

Illustrations: Kofler (loc. cit ) Pl 2, Figs 7 and 8.

 Choudrocecus columnaris (Davis) Ordaland Rucker. (Bacillus columnaris Davis, Bull. U. S. Bur. Fisherne., 35, 1923, 291, Ordal and Rucker, Proc Soc. Lieper. Biol and Med., 65, 1914, 18, also see Fish and lurker, Trans. Amer Fish Soc., 73, 1914 in prest; (Duphage columnaris Garujobst, Jour Bact., 49, 1915, 113)

I'tymology. I'rom Latin columnaria, rising in the form of a pillar.

sing in the form of a pillar. Vegetative cells: Flexible, weakly refractive, Gram-negative rods, 0.5 to 0.7 by 4 to 8 microns. Creeping motion observed on solid media, and flexing movements in liquids.

Spores (microcysts). 0.7 to 1.2 microns, spherical to ellipsoidal, occurring on both liquid and solid media.

Physiology Growth best on 0.5 to 0.9 per cent agar with 0.25 to 0.50 per cent Bactotryptone at pl17.3. Colonics on tryptone agar yellow, flat and irregular. Edge uneven with swarning appraent Gelatin luquefied rapidly. No indole. No reduction of nitrates. Starch, cellulose and agar not attacked. Sugars not fermanted, but glucos oviditard.

Fruiting hodies on agar not deliquescent, and surrounded by a firm membrane. A peculiar type of fruiting body formed in liquid media. Where organsens are in contact with infected tissues or with scales, produce columnar, sometimes bronched, fruiting bodies in which typical spores (uncrosysts) develop in 7 to 10 days.

Source and habitat: I'mst described as cause of batterial disease of warm water fishes (Davis, loc. ett) and later in fingerlings of the cold water blue black sulmen (Oncorrhynchus nerko). Transmissible to sulmoid fishes.

#### Genus 111. Anglococcus Jahn.

(Beitrige zur Protistologie 1 Die Polyangiden, Geli Bornteseger, Leipzig, 1921, 89) A segregate firm Myzococcus Thanter

Diagnosis Fruiting body consisting of nuirerous round (disk shaped) cysts, cyst wall thin, spores within.

Elymology Greek angion, vessel and kollos, coccus (tall)

The type species is Angiococcus disciforms (Tharter) Jahn

# Key to the species of genus Anglococcus.

Cysts yellow to dark orange yellow, disk shaped, 35 mirmus in diameter
 I. Angiococcus disciformis

B Cysts colorless to yellon, mund, up to \$3 rzierons in distreter.

2 Angiococcus cellul suri.

t Anglococcus disciformis (Thanter) Jahn (Myrococcus disciformis Thanter, thit, Gas, 37, 1001, 412, Jahn, liesträge

sur testamselen Protistologie I. Die Polyargulen, Gele Herntracker, Leipzig, 1921, 82 ) (Cent. f. Bakt., I Abt., Orig., 96, 1925, 426.) From sea water.

Spirochaeta minima Dobell. (Dobell, Arch. f. Prolistenk., 26, 1912, 117; not Spirochaeta mnima Petiti, Contribution a l'Étule des Spirochétidés, Vanves, II, 1928, 187 (Trepanena minimum Beaurepaire-Aragão and Vishna, Mem. Inst. Oswaldo Cruz, 5, 1913, 211.) One of the smallest known Spirochaeta, 0.5 by 2 0 to 2.5 microns. From water of the river Granta at Cambridge. Similar to Spirochaeta fuluarans.

Spirochacta viraz (Dobell) Zuelzer. (Treponema viraz Dobell, Arch. f. Protistenk., 26, 1912, 117, Zuelzer, 1925, in Prowazek, Handb. d. path. Protoz., 3, 1931, 1669.) From fresh water of the river Granta at Cambridge

Spirochaete kochti Trevisan. (Spirochaete des Wollsteiner See, Koch, in Colm, Beitr. z. Biol. d. Pflanzen, z. Hiet 3, 1877, 420; Trevisan, Batter. Ital., 1879, 26; Spirillum kochti Trevisan, I generie le specie delle Batteriacee, 1889, 24.) From water.

Spirochaete schroeteri Cohn. (Jahresber. d. Schles. Gesellch. f. 1883, 198; quoted from Schroeter, in Cohn, Krypt, Cog. Flora v. Schlesien, S, 1, 1889, 1885, Spirillum schroeteri Cohn, quoted from DeToni and Trevisan, in Saccardo, Sylloge Fungorum, S, 1889, 1007.) Similar to Spirochaete cohnii. From cellat walls.

# Genus 11. Saprospira Gross.

(Mittheil Zool Stat. zu Neapel, 20, 1911, 190.)

Spiral protoplasm without evident axial filament. Spirals rather shallow. Transverse markings or septe (?) seen in unstained and stained specimens. Perplast membrane distinct. Motility active and rotating. Free-living in marine occa.

The type species is Saprospira grandis Gross.

1 Saprospira grandis Gross. (Mitteil. Zool. Station zu Neapel, 20, 1911,

190) From Latin, great.
Cylindrical, 12 by 80 microns in

length, with obtuse ends

Spiral amplitude is 24 microns.

Waves large, inconstant, shallow, irregular, 3 to 5 in number, sometimes almost straight.

Axial filament absent.
Cross-striations present.
Membrane distinct
Division transverse
Flexible, clastic
Crista absent.

Source Found in intestinal tract of the

Habitat. Free-living in foraminiferous sand.

2. Saprospira puncta Dimitroff.

(Jour. Bact., 12, 1928, 146.) From Latin, pitted.

Large spirals: 1.0 by 88 microns with

pointed ends.

The spiral amplitude is 4 to 8 microns.

The average number of tu. 2s is 3.

Avial filament absent.

Cross-striations present.

Membrane distinct.

Division transverse.

Source. Found in oysters.

3 Saprospira lepta Dimitroff. (Jour. Bact , 12, 1926, 144.) From Latin, small. Large spirals: 0.5 by 70 0 microns, with pointed ends.

The spiral amplitude ranges from 5 to

13 microns.
The spiral width varies from 1 6 to 4.8

mierons.

The average number of turns is 6.

Axial filament absent.

Cross-striations present.

 Sporocytophaga myxococcoldes (Krzemieniewska Stanier. (Spirochaeta cytophaga Hutchinaon and Clayton, Jour. Agr. Sci., 9, 1919, 150; Cytophaga myxococodes Krzemienienska, Arch Mikrobiol., 4, 1933, 400; Cytophaga globulosa Stapp and Bortels, Cent f Bakt., II Abt., 90, 1934, 47, Cytophaga hutchinaonii Imeneeki and Solntzeva, Bull. Acad Sci. U.S.S.R., Ser. Biol., No 6, 1936, 1127; not Cytophaga hutchinsoni Winogradsky, Ann. Inst. Pasteur, 43, 1929, 578; Stanier, Jour Bact., 40, 1910, 630

Etymology . Modern Latin from generic namo Myzococcus, and eidos, like

Vegetative morphology: Flexible, singly occurring rods, 03 to 04 micron wide at the center, tapering to both ends. Length 3 to 8 microns according to Krzemienienska (loc cit), 25 to 5 mierons according to Jensen (Proc Linn Soc N So Wales, 65, 1940, 547) May be straight, bent, U-shaped or S-shaped Show ereeping motility (Stapp and Bortels, loc cit ) Stain poorly with ordinary aniline dyes; with Giemsa's stain, the young cells are colored uniformly except for the tips As the rods shorten and swell to form microevets, the chromatin becomes concentrated and muses toward the center of the cell, generally in the form of two parallel teands (Krzemieniewska, Acta Soe Bot Pol. 7, 1939, 514).

Microsysta: Spherical, 1.3 to 16 micross in disuncter, covered with a shealth of mucus. According to Krzemicnicasks (1920, loc cit), germination is by emergence of the shortened red from the sheath, followed by elongation; according to Stapp and Bortles (foc cit) and Instenecki and Solutieva (foc cit), by a simple elongation of the entire microsyst.

Growth is strictly confined to rellulose On mineral salts-silicagel plates covered with filter paper, yellow, glistening, slightly mucilaginous patches are produced after a few days. The color gradually assumes a light brownish tinge on aging. The filter paper in these regions is eventually completely dissolved and the patches become translucent.

Ammonia, nitrate, asparagin, aspartic acid and peptone can serve as sources of nitrogen (Jensen, loc. cit.).

Strictly aerobic.

Optimum temperature 28 to 30°C.

Source: Isolated from soil.

Habitat: Soil. Decomposes cellulose.

2 Sporocytophaga congregata Fuller and Norman. (Jour. Bact., 45, 1943, 567.)

Etymology: Latin congrego, to assemble.

Vegetative cells are long, flexuous reds with pointed ends, 0.5 to 0.7 by 5.5 to 8.0 microns. Creeping motility on solid surfaces.

Spores (microcysts): Spherical, 0.7 to 1.1 microns in diameter. Usually occur in localized regions within the colony.

Growth on starch agar is smoky, later turning yellow Colonies are irregularly round, slightly concave Edge is smooth

cells gather into groups and in these regions a large number of spherical spores are found.

Growth on rellulous destrin ager is pale; colonies are small and concave. Hollowing of the ager is limited to the area of colony growth

Glucose, galactose, lactose, maltore, eurose, arabinose, calcium gluconate, starch, cellulose dextrin, pectin, and hemicellulose are utilized. Filter paper is pot attacked

Ammonium, nitrate, and peptone are suitable nitragen sources

Indote not formed.

Nitrates not produced from nitrates

kaiserl. Gesundheitsamte, 50, 1909, 379; Bergey et al., Manual, 1st ed., 1923, 423.) From Latin, of a mussel.

Spirals: 0.5 to 3.0 by 10 to 60 microns, round in section with blunt ends, the one being slightly more pointed than the ather.

They have a ridge or comb running along one side but no terminal filaments.

Cross-striations distinct.

The chromatin granules are grouped in fours.

An undulating membrane can be demonstrated.

Source: Found in the intestinal canal of the scallop (Pecter jacobacus).

Habitat: From the crystalline style of molluses.

Appendix: Additional epecies which appear to belong in this genus are:

Cristispira acuminata (Schellack)
Ford. (Spirochaeta acuminata Schellack, Arb. kais. Gesundheitsamte, 30,
1909, 379, not Spirochaeta acuminata
Castellani, Brit. Med. Jour, 2, 1905,
1330; Ford, Texth of Bact., 1927, 939.)
From the crystalline style of a molluse,
Tapes lacfa.

Cristspira cardit: papillos (Schellack) Ford. (Spirochaeta cardit:papillos Schellack, Arb kais. Gesundheitsante, 30, 1909, 379, Ford, Textb. of Baet, 1927, 339.) From the crystalline style of a molluse. Cardium vapillosum

Cristispira chamae (Schellack) Noguchi (Spirochaeta chamae Schellack, Arb kais. Gesundheitsamte, 50, 1902, 379; Noguchi, Jour. Exp. Med, 27, 1918, 583.) From the crystalline styles of molluses, Chama spp.

Cristispira gastrochaenae (Schellack) Ford (Spirochaela gastrochaenae Schellack, Arb. kais. Gesundheitsamte, 50, 1909, 379; Ford, Textb. of Bact., 1927, 940.) From a shellfish, Costrochaena dubia. Constant length 29 microns

Cristispira helgolandica Collier. (Cent f. Bakt., I Abt. Orig., 86, 1921, 132.) Found three times in the body fluid of an echinoderm, Asterias rubens, in the North sea, Average length 63 microns. Named for the place where the investigation was made (Helgoland).

Cristispira interrogationis Gross. (Mittheil. Zool. Station zu Neapel, 20, 1910, 41.) From the intestinal canal of the

scallop, Pecten jacobacus.

Cristispira limae (Schellack) Ford. (Spirochaeta limae Schellack, Arb kais. Gesundheitisamte, 39, 1909, 379; Ford, Textb. of Bact., 1927, 933.) From the crystalline styles of molluses, Lima spp. Similar to Cristispira bubliantii.

Cristispira macirae (Prowazek) Ford. (Spirochacia macirae Prowazek, Arch. f. Schiffs- u. Tropenhyg., 14, 1910, 297; Ford, Textb. of Bact., 1927, 940.) From the digestive tract of a shellfish, Macira sulcatoria.

Cristispira mina Dintitroff. (Jour. Bact, 12, 1926, 159.) Found in cysters.

Cristispira modiolae (Schellack) Noguchi. (Spirochaela modiolae Schellack, Arb. kais. Gesundheitsamte, 50, 1909, 379; Neguchi, Jour. Evp. Med., £7, 1918, 583.) Found in mustels and systers.

Cristispira estreae (Schellack) Neguchi. (Spirochaeta estreae Schellack) Arb kais. Gesundheitsamte, 50, 1903, 879 Noguchi, Jour. Exp. Med., 27, 1018, 583) From the crystalline style of the oyster, Ostrea edulis. Identical with Cristispira anodoniae Gross.

Cristispira pachelabrae de Mello. (Compt. rend. Soc. Biol., Paris, 84, 1921, 211.) From the digestive tract of a shellfish. Pachelabra moestra.

Cristispira parvula Dobell. (Arch. f. Protisteak., 26, 1912, 117.) From the crystalline style of a molluse, Venus (Meretrix) castra, in Ceylon. The smallest Cristispira known—0.4 to 0.5 by 20 to 45 micross.

Cristispira peclinis Gross. (Mittheil. Zool Sta. zu Neapel, 20, 1910, 41.) From the digestive tract of a scallop, Peccen jacobacus. Identical with Cristispira balbianii Gross.

Cristispira polydorae Mesnil and Caul-

Membrane distinct.

Division transverse.

Source: Found in oysters in Baltimore, Maryland.

Appendix: The following species have been placed in this genus. Saprospira flexuosa Dobell. (Arch. f. Protistenk, 25, 1912, 117.) Isolated once from water of the river Granta at Cambridge.

Saprospira nana Gross. (Mittheil. Zool. Sta. zu Neapel, 20, 1911, 188.) From foraminiferous sand.

### Genus III. Cristispira Gross.

#### (Mittheil, Zool, Stat. 20 Neapel, 20, 1910, 41.)

Flexuous cell bodies in coarse spirals, 23 to 120 microns in length. Characterized by a ensta or thin membrane of varying prominence on one side of the body extending the entire length of the organism. Cross-striations. Actively motile, Found in the intestinal tract of molluses.

The type species is Cristispira balbianii (Certes) Gross.

 Cristispira babbianti (Certes) Gross. (Trypanesoma babbianti Certes, Bull.
 Soc. Zorl. de France, 7, 1882, 347; Spirochaeta babbianti Swellengrebel, Ann Inst
 Patt., 21, 1907, 562; Spirochaeta babbianti
 Borrel and Cernovodeanu, Compt. rend
 Soc. Biol., Paris, e3, 1907, 1102, Gross,
 Cent. f Pakt., I Abt., Orig, e5, 1912, 991

Cent. f Bakt, I Abt., Orig , 65, 1912, 90)
Cylindrical: 1 0 to 3 0 by 10 to 120
microns, with obtuse ends

Spiral amplitude is 8 microns. Spiral depth is 16 microns. Waves 2 to 5, sometimes more, large, Irregular,

shallow.

Axial filament absent Cross strictions present

Membrane distinct

Crista present, a ridge-like membrane making one to two complete turns

Terminal spiral filament absent Highly motile end portion absent

Stains, Cell membrane behaves like chitin or cutin substance. Stains voict by Giemen's solution, and light gray by iron hemotoxylin.

Trypein digestion: Membrine resistant, crists and strictions distinces.

Hile rolt (10 per cent). Crisia quickly dissolves

Saponin (10 per cent). Crista lecomes fibrillar, then indistinct. Source. From the crystalline style of oysters.

Habitat: Parasitic in alimentary tract of shell-fish.

2 Cristispira anodontae (Keysselitz) Gross (Spirochaeta anodontae Keysselitz, Arls. a d kaiserl. Gevundheitsmite, 23,1905,566; Gross, Cent f. Bakt., I Abt., Orig.,65, 1912, 000) From M. L., mussels

0.8 to 1.2 by 41 to 88 mirrons with sharply pointed ends, flattened and possessing an undulating membrane. The periphest is fibriller in apperance and there is a dark granule at each end of the undulating membrane. The chromatin material is distributed in the form of globules or clongated lands.

Large spirals. The average width of the spiral is 2 piecess. The average wave length is 8 piecess.

The number of complete turns ranges from 5 to 11

Habitat. Found in the erystalline style of fresh water inverses, Ancienta cygnea and A materials, also in intestinal tract of overers.

3 Cristispira pinnse (Gonder) Bergey et al. (Sperietaele pinnae Gonder, Cent. f. Bala., l. Ald., Orig., 47, 1976, 491; Spercelue's pinnae Schellack, Arb., a. d.

# FAMILY II. TREPONEMATACEAE SCHAUDINN.

(Deutsche med. Wochnschr., 51, 1905, 1728.)

Coarse or stender spirals, 4 to 16 microns in length; longer forms due to incomplete or delayed division. Protoplasm with no obvious structural features. Some may show terminal filaments. Spirals regular or irregular, flexible or comparatively rigid. Some visible only with dark field illumination. Parasitic on vertebrates with few exceptions. Some pathogenic. Many can be cultivated.

# Key to the genera of family Treponemataceae.

- I. Stains easily with ordinary aniline dyes.
- Genus I. Borrelia, p. 1058.

  II. Stain with difficulty except with Giemsa's stain and silver impregnation.

A. Strict anaerobes.

Genus II. Treponema, p. 1071.

B. Aerobes.

Genus III. Leptospira, p. 1076,

## Genus I. Borrella\* Swellenorchel.

(Swellengrobel, Ann. Inst. Past., 21, 1907, 582; Spiroschaudinnia Sambon, in Manson, Tropical Diseases, August, 1907, 833, Cacospura Enderlein, Sitzber. Ges. Natust. Freunde, Berlin, 1917, 390; Entomospira Enderlein, 1913, Spironema Bergey et al., Manual, 1st ed., 1923, 424; not Spironema Vuillemin, Compt. rend. Acad. Sci. Patis, 140, 1905, 1867; Spirochaeta Gieszczykiewicz, Bull. Acad. Polonaise d. Sci. et Lettres, Cl. Sci. Math. et Nat. 587 B, 1939, 24.)

Length 8 to 16 microns Coarse, shallow, irregular, with a few obtuse angled spirals. Generally taper terminally into fine filaments. Stain easily with ordinary anilize dyes. Refractive index approximately the same as that of true bacteria. Parasitic upon many forms of animal life. Some are pathogeoic for man, other mammals and birds. Generally bematophytes are found on mucous membranes. Some are transmitted by the bites of arthropads.

The type species is Borrelia anserina (Sakharoff) Bergey et al.

1. Borrelia anserina (Sakharoff) Bergey et al. (Spirochaeta anserina Sakharoff, Ann. Inst Past, 5, 1891, 564; Spirillum anserum (sic) Sternberg, Man. of Bact , 1893, 499; Spirillum anserinum Macé. Traité Pratique de Bact . 4th ed., 1901, 1060, Spirochaete anserina Mace, ibid.; Spiroschaudinnia anserina Castellani and Chalmers, Man. Trop Med., 2nd ed., 1913, 403; Spironema anserina Noguchi, Jour. Exp. Med., 27, 1918, 581; Bergey et al., Manual, 2nd ed , 1925, 435, Treponema anserina Noguchi, in Jordan and Falk, Newer Knowledge Bact and Immun., 1928, 456.) From Latin, pertaining to geese

Synonyms: Spirochaeta marchouxi Nuttall, Epidemiol. Soc., London, 24, 1904, 12 (Spirille de la poule, Marchoux and Salimbeni, Ann. Inst. Past., 17, 1903, 560, Spirochaela gallinarum Stephens and Christopher, Practical Study of Malaria and Other Blood Parasites, Liverpool, 1905; Borrelia gallinarum Swellengrebel, Ann. Inst. Past., 21, 1907, 623; Spirochaete gallinarum Lehmann and Neumann, Bakt. Diag., 4 Aufl., 2, 1907, 623; Spironema gallinarum Gross, Cent. l. Bakt., I Abt., Orig., 65, 1912, 92; Spiroschaudinnia marchouxi Castellani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 403; Spironema marchouzi Ford,

<sup>\*</sup>Further revision of the genus by Prof. E. G. D. Murray, McGill Univ., Montreal, P. Q. Canada, April, 1947. Reviewed by Dr. Gordon E. Davis, Rocky Mountain Laboratory, U.S.P.H.S, Hamilton, Montana.

lery. (Compt. rend. Soc. Biol, Paris, 79, 1916, 1118; Cristispirella palydorae Hollande, Compt. rend Acad Sci Paris, 172, 1921, 1696). From a manne annelid, Polydora flata.

Cristispira pusilla (Schellack) Ford. (Spirochaeta pusilla Schellack, Arh kais Gesundheitsamte, 59, 1909, 379; Ford, Textb of Bact, 1927, 940) From the digestive tract of a mussel, Anodonta mutchilis

Cristispura sazicavae (Schellack) Pord (Spirochaeta sazicavae Schellack, Arb hais Gesundhoftsamte, 50, 1909, 379, Ford, Texth. of Bact., 1927, 940) From the crystalline style of a molluse, Sazicava articles

Cristispira spiculifera (Schellack) Dimitroff. (Spirochaeta spiculifera Schellack, Arb. kais Gesundheitsamte, 30, 1909, 379, Dimitroff, Jour Bact, 12, 1926, 157.) Found in mussels

Cristispira tapetos (Schellack) Gross (Spirochaeta tapetos Schellack, Arb kais. Gesundheitsamte, 50, 1909, 379; Gross, Cent. f. Bakt, I Abt., Orig., 65, 1912, 81.) From the crystalline style of a molluse, Tapes decussata.

Cristispira tenua Dimitroff. (Jour. Bact., 12, 1923, 160.) Found in systems. Cristispira teneris Dobell. (Quart. Jour Microse Sci., London, 54, 1910-1911, 507 and 191d, 56, 1911, Part 3) From a clam, Venus (Meretriz) castra, in Ceylon Identical with Cristispira balbuarti Gross.

Cristspirella cartae Hollando. (Compt rend Acad. Sci. Paris, 1728, 1924, 1603) From the intestine of a guinea pig. Probably a protocoan. Evidently the same as Heliconema (see appendix to Borretia) Both Cristispirila Polydorae and Cristspirila carnae have characteristics at variance with accepted ideas of epirochaetes.

Spirochaeta solenis Fantham. (Ann. Trop. Med and Parasitol., 5, 1911, 479.)
A parasite of a molluse, Solen ensis.

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MANUAL OF DETERMINATIVE BACTERIOLOGY
          bb. Non-motile.
                c. Grows readily at 37°C.
                                  16. Pseudomonas smaragdina.
               cc. Grows poorly or not at all at 37°C.
                                  17. Pseudomonas chlorina.
    aa. Gelatin not liquefied.
          h. Polar flagellate.
               c. Grow readily at 37°C. Usually bluish-green.
                                 18. Pseudomonas oleovorans.
                                 19. Pseudomonas incognita.
                                 20. Pseudomonas convexa.
                                 21. Pseudomonas mildenbergis.
              cc. Grow poorly or not at all at 37°C.
                     d. Milk not coagulated.
                                22. Pseudom nas putida.
                                 23. Pseudo monas scissa.
                                24. Psev domonas ovalis.
                                 25. P. Zeudomonas striata.
                                26. Pseudomonas denitrificans.
                   dd. Milk coar Culated.
                                27. Pseudomonas solaniolens.
        bb. Non-motile.
              c. Grows poorle:
                     d Mill for or not at all at 37° C.
                            not congulated.
                                  28. Pseudomonas eisenbergis.
2. Green fluorescent pigmer
                          Let not produced or not reported.
    a. Gelatin liquefied.
         b. Polar flagellatifg
              c. Grow po
                         porly or not at all at 37°C. No visible gas from
                    d. I
                         plapid reduction litmus. Putrid odor.
                                  29. Pseudomonas putrefaciens.
                         Slow reduction litmus. Alkaline.
                                  30. Pseudomonas mephilica.
                                  31. Pseudomonas geniculata.
                       scAcid congulated.
                                  32. Pseudomonas fragi.
             cc. Acid a
                         nd visible gas from glucose. Optimum tempera-
                  ture
                        I. variable.
                   d.
                        Litmus milk reduced and alkaline.
                                  33. Pseudomonas nebulosa.
                  dd. len, itmus milk acid coagulated.
                                  34. Pseudomonas coadunata
                                  35. Pseudomonas multistriata.
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Pseudomonas punciala.
 Pseudomonas hydrophila.
 Pseudomonas ichthuosmia.

Textb. of Bact., 1927, 955; Spirechacla gallinaa Ford, idem; Treponema gallinarum Noguch, in Jordan and Falk, Nener Knowledge Bact. and Immun, 1928, 461; Treponema marchauri Gay et al. Agents of Disease and Host Resistance, 1935, 1077). The cause of septicesemia in chickens.

Spirochaela granulosa penetrans Balfour, Jour. Trop. Med and Hyg. 10, 1907, 153 (Spiroschaudinnua granulosa Balfour, Jour. Trop Veter., Calcutta, 6, 1910, 309; Spironema granulosa Ford, Textb of Bact, 1927, 957) From spirochetosis of lowls in Sudan.

Spirochota niceller Brumpt, Bull Soc Path. Evot, p. 1909, 255 and/or Précis de Parasitel, Paris, 1st ed., 1910 (Galli-Valerio, Cont. f. Bakt, I. Abt, Ong., 50, 1900, 189 and 61, 1912, 259; Spironema niceller Ford, Tevth of Bact, 1927, 958; Treponema niceller Gry et al., Agents of disease and Host Resistance, 1935, 1977) From spirochetosis of geece in Tunsia.

Spirochaeta neteuri Brumpt, Bull So-Path, Feot, §, 1909, 283 (Spirocchaudina na nereurii Castollani and Chalmers, Man Trop. Med, 2nd ed., 1913, 401; Spironema nereuri Ford, Textb of Bact, 1927, 035, Treponema nereuri Gay et al., Agents of Diesson and Host Resistance, 1933, 1077). The causo of fonl spirochetosis in Sengel.

Spirochaeta gallinarum var heredilaria Neumann and Mayer, in Lebmann,

Med Atlanten, 11, 1914, 276 A North African strain of fowl spirochetosis Borrelia pullorum Redowitz, Amer

Jour Med. Technol, 2, 1936, 91 From diseased chickens Spirochaeta analis Parrot, Bull Soc

Path. Exot , 15, 1920, 647. Pathogenie for domestic ducks in Algeria.

Morphology, 0.25 to 0.3 by 8 to 20 microns, averaging about 1 spiral per micron.

Actively motile, with Isshing movements

Stains readily with amline dyes and Giemsa's stain Cultivation: Can be cultivated in Noguchi's ascitic fluid-rabbit kidney medium

Immunology: Antigenically distinct from species found in mammals.

Arthropod vectors: Transmitted by the bites of ticks (Argas persicus, A. miniatus, A. reflexus and Ornithodoros moubala)

Pathogenic for birds but not for mammals.

Source From blood of infected greec, ducks, fowls and vector ticks.

Habitat The cause of spirochetosis of fowls

2 Borrelia recurrentis (Lebert) Bergey et al (Obermeier, Berlin klin, Wochschr., f873, f52; Protomycetum recurrentis Lebert, Ziemssen's Handbuch, 2, 1874, 267; Spirochaete obermeteri Cohn, Beitr. 2 Biof d Pflanzen, I, Heft 3, 1875, 196; Spirillum obermeieri Zopf, Dio Spaltrulze, 3 Aufl., 1885, 71; Spirochaela obermeters Migula, in Engler and Pmntl, Die naturl. Pflanzenfam , 1, 1a, 1895, 35; Spirochaete recurrentia Lehmann and Neumann, Bakt. Diag., 4 Aufl., 2, 1907. 621; Spirochaela recurrentis Castellani and Chalmers, Man. Trop Med., 1st ed., 1910, 305; Spironema recurrentis Gross. Cent. f. Bakt , I Abt , Orig , 65, 1912, 85; Spiroschaudinnia recurrentis Castellani and Chalmers, Man Trop Med , 2nd ed., 1913, 393, Spironema obermeteri Park and Williams, Pathogenic Microorganisms, 6th ed . 1917, 513. Caeospira recurrentis Enderlein, Sitzungsber d Gewillsch. naturf. Freunde, f917, 313; Treponema recurrentis Brumpt, Nouveau Tmité de Médeeme, Paris, 4, 1922, 508, Treponema obermesers Brumpt, thid; Cacospira obermeiers Enderlein, Bakterien-Cyclogenie. 1925, 251, Bergey et al , Manual, 2nd ed , 1925, 433, Spirillum recurrentis Ford, Textb of Bact , 1927, 918, Spiroschaudinnea obermeiere Ford, thid.) I'rom latin, recurring

Cyfindrical or slightly flattened, 0.35 to 0.5 by 3 to 16 microns, with pointed ends.

Spiral amplitude 1.5 microns.

Spirals large, wavy, inconstant, about 5 in number.

Terminal finely spiral filaments present.

Highly motile end portion absent.

Motility: By active cork-screw motion without polarity. Lashing movements common in drawn blood.

Stains with common aniline dyes. Gram-negative. Violet with Giemsa's stain.

Bile salts (10 per cent): Disintegration complete,
Saxonia (10 per cent): Immobilized in

Saponin (10 per cent): Immobilized in 30 minutes, then broken up in a few hours. In some a skeletal structure remains.

Cultivation: Can be cultured in ascitle or hydrocool fluid to which a piece of sterile rabbit kidney is added. Optimum reaction pli 7.2 to 7.4.

Immunology: Serum does not agglutinate Barrelia duttons.

Accidental and experimental transmission by conjunctival sac and skin abrasions.

Disease in experimental animals (small rodents after monkey passage) mild.

Arthropod vector. Louse (Pediculus humanus) which evhibits normal transmission from the 16th to the 28th day. Found in the bed-bug (Comex lectularius) and ticks, but not transmitted by them. No evidence of hereditary transmission in the louse.

Habitat The cause of European relapsing fever. Transmissible to man, monkeys, mice and rats.

3. Borrella duttoali (Novy and Knapo) Bergey et al. (Dutton and Todd, British Med. Jour., 2, 1903, 1259; Sperallum dultoni Novy and Knapp, Jour. Infect. Dis., 3. March. 18, 1963, 226; Spirochaeta duttoni Breial, Lancet, I. June 16, 1903, 1609; Spirochaeta duttoni Lehmann and Neumann, Bakt. Dasg., 4 Aufl., 2, 1907, 623; Spironada duttoni Gross, Cent. 6. Bakt., I Aba Crig., 65, 1912, 94; Spirochaeta Microspironema duttoni Duboscq and Lebailly, Compt. rend. Acad. Sci., 164, 1912, 663; Spiroschaudinnia duttoni Castelliani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 299; Treponema duttoni Brumpi, Nouveau Traité de Médecine, Paris, 4, 1922, 497; Caccapira duttoni Endetlein, Bakterien-Cyclogenie, 1925, 254; Bergey et al., Manual, 2nd ed., 1925, 431.) Named for Dutton, who discovered this orranism.

Morphology: Similar to Borrelia recur-

Cultivation: Growth occurs under anaerobic conditions in serum water, hydrococl or ascitic fluid to which a piece of sterile rabbit kidney is added.

Immunology: This organism is antigenically distinct from other causes of relapsing fever.

Pathogenic for mice and rats. Disease in small redents and many other experimental animals very severe

Arthropod vector: This species is transmitted to man through the bite of the tick (Ornithodoros moubala) by feral contamination of the bite. In the tack the organism goes through some granulation or fragmentation phenomenon, the nature of which is not understood Hereditary transmission to at least the third generation of the tick. Not transmitted by the louse.

Habitat: The cause o' Central and South African relapsing 1; er.

4. Borrelis kochil (Novy) Bergey et al. (Spirocheeta lochi Novy, Proc Path. Soc. Philadel., N S. 10, 1907, 1; Spirocheeta rossi Nuttall, Jour. Roy. Inst. Pub. Health, Loadon, 16, 1903, 285; Spirocheetanian ar ossis Castellani and Chalmers, Man. Trop Med., 2nd ed., 1916, 490; Spironema Lochii Noguchi, Jour. Exp. Med., 27, 1918, 581; Treponema kochi Brumpt, Nouveau Traité de Médicine, Paris, 4, 1922, 497; Treponema rossi Brumpt, vidit, Bergey et al., Manual, 2nd ed., 1925, 434; Borelia rossi Statal, 2nd ed., 1926, 432, 2nd ed., 1926, 2nd ed., 1926, 2nd ed., 1926, 2nd ed., 1926,

Named for Koch, who first observed spirochetes in East African relapsing fever.

Morphology . Similar to that of Barrelia recurrentis.

Cultivation Same as for Borrelia recurrents.

Immunology: Antigenically distinct from both Borrelia recurrentis and B. duttonii.

Pathogenie for mice and rats

Arthropod vector No record. Habitat: The cause of African relapsing fever.

5. Borrelia novvi (Schellack) Bergey et al. (Spirochaete from relapsing fever, Norris, Pappenheimer and Flournoy, Jour Inf. Dis , 3, 1906, 266, Spirochaeta novyı Schellack, Arb. kaiserl. Gesundheitsamte, 27, 1907, 199 and 364, Spirenema novy: Gross, Archiv f. Protistonk, 24. 1912, 115; Spiroschaudinnia norys Castellani and Chalmers, Man. Trop Med., 2nd ed., 1913, 400; Treponema norm Brumpt, Nouveau Traité de Médecine. Paris, 4, 1922, 508, Cacospira noryi Enderlein, Bakterien-Cyclogenie, 1925, 251; Bergey et al., Manual, 2nd ed , 1925, 431) Named for Novy, the American bacteriologist

Morphology Similar to that of Borrelia recurrentis.

Cultivation · Samo as for Borrelia re-

Immunology. Antigenically distinct from other relapsing fever organisms

Pathogenic for monkeys, white rats and white mice.

Arthropod vector. Unknown Habitat Recovered from a patient in Bellevue Hospital, New York Origin of infection unknown

6 Bortella berbera (Sergent and Foley) Bergy et al (Spirocharla berbera Sergent and Foley, Ann Inst Past, 24, 1910, 337, Spirochaudinnia berbera Castellani and Chalmers, Man. Trop Med., 2nd ed. 1913, 402; Spironema Berbera

Noguehi, Jour. Exp. Med., 27, 1918, 584, Spirochaeta berbera Kolle and Hetsch, Exper. Bakt. u. Infekt., 6 Aufl., 1, 1922, 811; Treponema berberum Brumpt, Nouveut Traité de Médecine, Paris, 4, 1922, 496, Bergey et al., Manual, 2nd ed., 1925, 430. Named for the Berbers, a tribe of Northern Almen.

Morphology: More tenuous than other relapsing fever organisms, 0 2 to 0 3 hy 12 to 21 microns.

12 to 21 inscions,

Cultivation: No record of its cultivation.

Immunology: Antigenically distinct from Borrelia recurrentis. Arthropod vector: Possibly carried by

the louse (Pediculus restiments).

Source Found in cases of relapsing fever in Algiers, Tunis and Tripoli.

Habitat: Cause of relapsing fever in North Africa. Is virulent for monkeys. Produces non-fatal infections in rats and mice

7. Borrella carteri (Mackie) Bergey et al. (Spirochaeta carteri Mackie, Ann. Trop Med and Parasitol., I, 1907, 157 and Indian Med. Gazette, 44, 1908, 370; Spirillum carteri Machie, Lancet, 2, 1907, 832, according to Ford, Textb. of Bact .. 1927, 950; Spiroschaudinnia earleri Castellani and Chalmers, Man. Trop. Med., 2nd ed. 1913, 401; Spironema carteri Nogucia, Jour Exp Med , 27, 1918, 581; Treponema carters Brumpt, Nouvenu Traité de Médecine, Paris, 4, 1922, 497. Bergey et al , Manual, 2nd ed , 1925, 435 ) Named for Carter, who in 1879 described this organism in the blood of patients with Indian relapsing fever.

Morphology: Similar to Borrelia berbera.

Cultivation Not recorded.

Immunology: Probably a distinct speces A succession of distinct scrological type-occurs with the relapses in a single infection (Cumungham et al., Far Lastern Association of Tropical Medicine, Tol yo. 1925; Imban Journal of Medical Research, 22, 1934-1935, 105 and 595; ibid., 24, 1937, 571 and 581).

Arthropod vector: Carried by either Pediculus vestiments or Cimex rotundatus or by both.

Habitat: The cause of Indian relapsing fever. Transmissible to monkeys, rabbits, rats and mice

8. Borrelia thelleri (Laveran) Bergey et al. (Spirochaeta theileri Laveran. Compt. rend. Acad. Sci., Paris, 136, 1903, 939; Spiroschaudinnia theileri Castellani and Chalmers, Man. Trop Med .. 2nd ed., 1913, 404, Spironema theileri Noguchi, Jour. Evp Med., 27, 1918, 584; Bergey et al., Manual, 2nd ed., 1925, 435; Spirillum theilers and Spirochaele theileri Pettit, Contribution à l'Étude des Spirochétidés, Vanves, II. 1928: Treponema thesleri Noguchi, in Jordan and Falk, Newer Knowledge Bact. and Immun., 1928, 461) Named for Thetler, who discovered this organism in 1902 in Transvaal, South Africa

Morphology, 0 25 to 0.3 micron by 20 to 30 microns with pointed ends.

Cultivation. No record

Immunology. Is distinct from the species infecting man.

Arthropod vector. Transmitted by the tick (Rhipicephalus decoloratus)

Source · Blood of cattle.

Habitat. Blood of cattle and other mammals in South Africa

9. Borrella glossinae (Novy and Knapp) Bergey et al (Spirillum glossinae Novy and Knapp, Jour. Inf. Dis., 3, 1906, 385; Spirochaeta glossinae Castellani and Chalmets, Man Trop. Med, 1st ed., 1910, 310, Spirosehaudnaia glossinae Castellani and Chalmers, tōid., 3rd ed., 1919, 454; Spironema glossinae Bergey et al., Manual, 1st ed., 1923, 425; Bergey et al., Manual, 2nd ed., 1925, 435, Entomospira glossinae Enderlein, Bakterien-Cyclogenie, 1925, 254; Treponema glossinae Ford, Textb of Bact., 1927,

988.) Named for the genus of insects, Glossina.

Morphology: 0.2 by 80 microns, occurring singly, sometimes in pairs. Generally 4 spirals. Shorter, narrower and has more turns than has Borrelia recurrentis

Habitat: Found in the stomach contents of the ise-tse fly (Glossina palpalis).

Borrelia buccale (Steinberg) Brumpt. (Spirochaeta buccalıs Steinberg, 1862, according to Hoffmann and Prowazek, Cent. f. Bakt., I Abt., Orig., 41, 1906, 819; Spirochaete cohnii Winter. Die Pilze, 1879, 61; (?) Microspira buccalis Lewis, The Lancet, 1884, quoted from Schroeter, in Cohn, Kryptog Flora v. Schlesien, S, 1, 1889, 169; Spirochaete buccalis, quoted from Schroeter, ibid, 168; Spirillum cohnii Trevisan, I generi e le specie delle Batteriacee, 1889, 24; Spirillum buccale Mace, Traité Pratique de Bact , 4th ed., 1901, 1062; Spirochaeta inaequalis Gerber, Cent. f. Bakt , I Abt., Orig., 56, 1910, 508; Spirochaela undulata Gerber, idem; Treponema buccale Dobell, Arch. f. Protistenk . 26, 1912, 117, Spironema buccale Gross, Cent. i. Bakt , I Abt., Orig., 65, 1912, 81; Spiro. schaudinnia buccalis Castellani and Chalmers, Man. Trop. Med , 5rd ed., 1919, 450; Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 495; Treponema inaequale Brumpt, sbid.; Treponema undulatum Brumpt, sbid., 514.) From Latin buccalis, buccal.

Morphology 0 4 to 0 9 by 7 to 20 mierons. The largest of the mouth spirochetes.

Motility: Active, serpentine, rotating and flevuous.

Staining: Stains with aniline dyes and is violet with Giemsa's stain

Cultivation: Has not been obtained in pure culture and probably does not grow in any medium tried to date.

Habitat: In normal mouths and invades formed lesions of the respiratory mucous membrane.

 Borrella vincentii (Blanchard) Bergey et al. (Spirochaeta vincenti Blanchard, Arch. f. Protistenk , 10, 1906, 129; Spirochaeta schaudinni Prowazek, Arb. kaiserl. Gesundheitsamte, 22, 1967, 23; Spirochaete plaut-rincenti Lehmann and Neumann, Bakt, Diag , 5 Aufl , 2, 1912, 579, Spiroschaudinnia vincenti Castellani and Chalmers, Man. Trop. Med., 2nd ed. 1913, 402, Spiroschaudinnia schaudinni Castellani and Chalmers, idem. Spironema uncenti Park and Williams, Pathogenic Microorganisms, 6th ed , 1917, 506; Treponema vincenti Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 514; Treponema schaudinni Brumpt, idem; Bergey et al., Manual, 2nd ed . 1925, 435.) Named for Vincent, the French bacteriologist.

Morphology 0.3 by 8 to 12 microns, 3 to 8 irregular shallow spirals. Stains easily with the common aniline dyes and is Gmm-negative

Motility Has a mpid progressive and vibratory motion

Cultivation Can be cultivated under anaemhic conditions. Cultures may show long forms with only a writhing motion.

Not pathogenic for laboratory animals. Habitat. Found on normal respiratory mucous membrane and is associated with a fusiform bacillus (Fusobacterium plauti-vincenti) in Vincent's augina

12 Borreita refringens (Schaudina and Hoffmann) Bergy et al Ø5prechaela refringens Schaudinn and Hoffmann, Arbeiten kaiserl. Gesundhestamte, 22, 1903, 525; Spirochaela refringens Hoffmann and Prowazek, Cent f Bakt, I, Alt, Orig, 44, 1906, 712; Spirochaema refringens Gross, Arch f Protistenk, 24, 1912, 115, Spirochaudenma refringens Gastellani and Chalmers, Man. Trop Med., 3rd ed., 1919, 439; Trepomera refringens Castellani and Chalmers, bidd., 461; Bergey et al., Manusl., 2nd ed., 1923, 430; I rem Latin, refractive-di, 1923, 430; I rem Latin, refractive-disconnections of the second control of the second con

Morphology: 0.5 to 0.75 by 6 to 20 microns. Spirals are coarse and ahallow. Spirals are generally smoothly rounded and regular, tapering towards the end into a fine projection Stains easily by common dyes In stained specimens the spirals appear irregular

Motility. Active serpentine and rotating motion with marked flexion

Cultivation. Uncertain Pathogenicity None.

Source Found with Treponema pallidum in some cases of syphilis as originally described by Schaudinn

Hahitat. Genital mucous membranes and necrotic lesions of the genitalia of man.

13. Borrella hyos (King and Drake) Bergey et al. (Hog cholern virus, King and Baeslack, Jour Inf Dis., 12, 1918, 30; Spirochaela sutz King, Baeslack and Hoffmann, Jour. Inf. Dis., 12, 1913, 235; not Spirochaela suiz Bosanquet, Spirochetes, Saunders, 1911, Spirochaela hyos King and Drake, Jour. Inf. Dis., 18, 1915, 51, Spirochem hyos Bergey et al., Manual, lat ed., 1923, 426, Bergey et al., Manual, 2nd ed., 1923, 436, Spirochem suiz Ford, Texth. of Bact., 1927, 999) From Greek, hog

Morphology . 1 nucron by 5 to 7 mlemns Distinctly shorter and thicker than other members of the genus

Motility Active spinning motion, apprals fixed.

Cultivation Grows under anaerobic conditions in the presence of tissue.

Habitat. Found in the blood, intestinal ulcera and other lesions of hogs suffering from hog cholera

14 Borrelta herms! (Davis) Steinhaus. (Spirochaeta herms! Davis, Amer. Assoc. Adv. Sci., Pub. No. 18, 1912, 16; Steinhaus, Insect. Microbiology, 1916, 453.)

Investigations by Davis (loc at ) indicate that each species of Ornithodoros that is a relapsing fever vector carries a spirochete that is tick-host specific and that this host specific relationship offers a more accurate approach to the differentiation of relapsing fever approachetes than any of the several criteria previously used.

This was shown to be the case for Borrelia kerms! and Borrelia parker; For this reason no attempt is made to describe the morphology and other characters of the relapsing fever spirochetes of North and South America.

Borrelia herms: is transmitted by Ornithodoros hermsi.

A cause of relapsing fever in the Western part of the U.S.A.

15. Borrelia parkeri (Davis) Steinhaus. (Spirochaeta parkeri Davis, toc. cit.; Steinhaus, loc. cit.)

Transmitted by Ornithnodoros parkeri.
A cause of relapsing fever in the Western part of the U.S.A.

 Borrelia turicatae (Brumpt) Steinhaus (Spirochaeta turicatae Brumpt, Comp. rend. Soc. Biol., Paris, 115, 1933, 1369; Steinhaus, loc. ctt.)

Transmitted by Ornithodoros turicata.

A cause of relapsing fever in Mexico,
Texas and nearby areas.

 Borrelia venezuelensis Brumpt (Treponema venezuelensis Brumpt, Nouveau Traité de Médecine, Paris, 4, 1921, 492; Brumpt, ibid., 495; Spirochaeta Lenezuelensis Pettit, Contributions à l'Étude des Spirochétidés, Vanves, 2, 1928, 295)

Transmitted by Ornethodoros rudis (O. renezuelensis).

A cause of South American relapsing fever.

Brumpt (Précis de Parasitologie, 3rd ed., Paris, 1936) regards thus species as identical with Borrelia neotropicalis (Bates, Dunn and St John) Steinhaus. (Treponema neotropicalis Bates, Dunn and St John, Amer. Jour. Trop. Med , 1, 1921, 183, Spirochaeta neotropicalis St John and Bates, Amer. Jour. Trop. Med 2, 1922, 251; Steinhaus, Ice cit.: Transmitted by Ornithodoros venezuelasis A cause of relapsing fever in Panamas.

Appendix: Many of the species included in this appendix are so inadequately described that it is not certain that they belong in this group.

Borelta phagadenis (Noguchi) Bergey et al. (Spirochastla phagadenis Noguchi) Jour. Exp. Med., 46, 1912, 261; Spirochastla phagadenis Castellani and Chalmers, Man. Trop. Med., 2nd ed, 1913, 403; Treponema phagadenis Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 611; Spironema phagadenis Bergey et al., Manual, 1st ed., 1923, 426; Bergey et al., Manual, 2nd ed., 1925, 435.) From phagadenous ulcer.

Heliconema pyrphoron Scholer. (Ceot. f. Bakt., I Abt., Orig., 188, 1937, 342.) From human blood. Pathogenic.

Heliconema vincenti Sanarelli. (Ann. Inst. Past., 41, 1927, 701.) From the intestine of a guinea pig. Shows stages between spirochetes and fusiform bacilli (See Hindle, Med Res Council Syst. of Bact. 3, 1931, 130)

Microspironema merlangi Duboscq and Lebailly. (Compt. rend. Acad. Sci. Paris, 154, 1912, 662) From the whiting, Merlangus merlangus. May be a synonym of Spirochasta gadi.

Spirillum gondii Nicolle, (Nicolle, Compt. read. Soe Bol., Paris, 85, 1907, 213; Spruchaeta gondi Zuelter, 1925, In Prowazek, Handb d. path. Protor., 5, 1931, 1689.) Found in the blood of ordent, Ctenodactylus gor. 7. Not pathogenic. Associated with a piroplasma Probably not a spiroche<sup>4</sup>.

Spirillum latapici Laveran. (Laveran, Bull. Soc. Path. Evol., 1, 1908, 148; Spirochaeta latapici Zuelzer, 1925, in Prowazek, Handb. d. path. Protoz., 5, 1931, 1633; Spironena latapic; (sic) Ford, Tevth. of Bact., 1927, 964.) From the blood of a shark.

Spirillum pitheci Thiroux and Dufougeré. (Thiroux and Duloungeré, Compt. rend. Acad. Sci. Paris, 189, 1910, 132; Spirochaela pitheci Zuelter, 1925, in Prowazek, Handb. d. path. Protoz., 5, 1931, 1676; Spironema pitheci Ford, Textb. of Bact., 1927, 961.) From the blood of an African monkey, Cercopithecus pata; Pathogenic for monkeys, rats and field mace. Closely related to Borrelia dutionii

Spirochacta aborginalis Cleland (Cleland, Jour. Trop Med., 12, 1909, 143, Spirochaudinnia aborginalis Castellan and Chalmers, Man. Trop. Med., 2nd ed., 1913, 402, Treponema aborsignalis Brumpt, Nouveuu Traité de Médicene, Paris, 4, 1922, 491.) Found in eases of granulora inguinale in West Australia Probably's aprophytic

Spirochaela acuminata Castellam (Castellam, Brit. Med Jour, 2, 1908, 1330, Spirochaeta tenuis acuminata Castellam, idem and/or Arch I Schiffs-u Troponbyg, Iz, 1903, 311, Spirochaediana acuminata Castellami and Chalmers, Man Trop Med, 3rd ed, 1919, 449, Treponema acuminatum Brumpt, Nouveut Traité de Médecine, Paris, 4, 1922, 495) From ulcerated lesions of yaws Spirochaeta acuta Kirchewski and

Séguin (Rev. de Stomatol, 22, 1920, 613) From the gral cavity. Spirochaeta aeglefini Henry (Jour Path and Buct, 18, 1913, 222) From

haddock
Spirochaeta oegyptica Gonder (Gonder, in Prowazek, Handli, d. path. Protoz, d., 1914, 671; Spironema oegyptice
Noguchi, Jour Exp. Med., 27, 1918, 581,
Trepontena egypticum Brunpit, Nostreau
Traité de Médreine, Paris, 4, 1922, 500,
Borretia orgypticum Steinhaus, Insect
Microbiology, 1916, 482; Observed in
cases of relapsing fever in Sudau. Prub
alby a spinosym of Borretia recurrentia.

Spirochaela ambigum Séguin and Vincent (Séguin and Vinrent, Compt rend See Biol., Paris, 121, 1996, 408, Treponema ambigum Prévot, Mun Class et Detenn. d Betelies Anasfrohes, Paris, 1910, 293.) From the oral exsity and the lungs Pathogenic Strictanse robe

Spirochaeta amphibiae Yakimoff and Miller. (Bull See Path. Liot, 18, 1925, 306) From the intestines of frogs, Rana temporaria.

Spirochaeta argentinensis Kulin and Steiner. (Kuhn and Steiner, Med Khn . 13. 1917. 1007; Spirochaeta polyscleratica Arzt and Kerl, according to Pettit. Contribution à l'Étude des Spirochétidés, Vanves, II, 1928, 134; Trepanema (?) argentinensis Noguchi, in Jordan and Falk, Newer Knowledge Baet and Immun, 1928, 478 ) From the livers of guinea pigs and rabbits inoculated with blood from patients having multiple selerous Pathoconic for man, monkeys. dogs, rabbits and guinea pigs Named for the Latin name of the town of Straybourg (Argentoralum)

Spirochaeta balantidis Hoffmann and Prowarck (Hoffmann and Prowarck, Cent. f Bakt. I Abt. Orig., 41, 1906, 741; Spirochaedinnie balantidis Castellanii and Chalmers, Man. Trop. Med., 2nd ed., 1913, 401, Spironema balantidis Park and Williams, Pathogenic Microorganisms, 6th ed., 1917, 605; Treponema balantidis Brumpt, Nouveau Traltid de Médeene, Paris, 4, 1922, 490.) From a caso of balantis.

Spirochaeta boria-caffris Nuttall. (Nuttall, Parasitology, 3, 1910, 108; Spironema boris-caffris Ford, Textb of Bact, 1927, 950) From the blood of a buffalo.

Spirochaeta bronchialia Custellani (Castellani, Ceylon Medical Reports, 1907; Spirochaudinnia bronchialia Castellani and Chalmera, Man Trop Med, 2nd ed, 1913, 492, Terpontum bronchiale Brumpt, Nouveut Traité de Médecine, Paris, 4, 1922, 490). Found in cases of bronchitis in Ceylon. A misture of sevcral species of mouth spirochaetes is apparently described under this designation.

Spuredacta bucco plaryngei Micfie, (Macfie, Ann Trop Med and Parasitol, 10, 1916, 329, Treponena bucco-pharyngei Brumpt, Nouveau Trutte de Midecine, Paras, 4, 1922, 477; I Fran the throat of a native of the Gold Coast. May be deutical with Spirochata denium or S buccofti. Spirochaeta bufonis Dobell, (Dobell, Quart. Jour. Microsc. Sci., £2, 1908, 121; Spiroschaudinnic bufonis Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 545; Spironema bufonis Ford, Textb. of Bact., 1927, 986; Treponema bufonis Ford, thid.) From the intestines of a toad. Bufo vulcaris.

Spirochasta enesirae retortiformis Hellmann. (Arch. f. Protistenk., 29, 1913, 22.) From the urinary sac of a tunicate.

Caesira retortiformis.

Spirochaeta caesirae septentrionalis Hellmann. (Arch. f. Protistenk., 29, 1913, 22.) From the urinary sac of a tunicate, Caesira septentrionalis.

Spirochaeta canina Bosselut. (Bull. Soc. Path. Evot., 18, 1925, 702.) From

the blood of a dog.

Spirochaeta canis Mache. (Ann. Trop. Med. and Parasitol., 10, 1916, 305.)

From dog feces.

Spirochaeta cobayae Knowles and Basu (Knowles and Basu, Indian Jour. Med. Res., 22, 1935, 449; Treponema cobayae Topley and Wilson, Princip. Baet. and Immun., 2nd ed., 1936, 725; Borrelia cobayae Steinhaus, Insect Microbiology, 1946, 454.) From the Ulood of guinea pigs Blood parasite belonging to the relapsing lever group. Pathogenic for guinea pigs, rabbits and white rate.

Spirockaela comandons Séguin and Vinzent. (Séguin and Vinzent, Compt. rend. Soc. Biol., Paris, 121, 1936, 405; Treponema comandons Prévot, Man. Class. et Determ. d Bactéries Anaérobies, Paris, 1940, 208) From the ordi cavity. Rather common Non-patho-

genic. Strict anaerobe.

Spirochaeta crocidurae Leger (Leger, Bull. Soc. Path. Exot. 10, 1917, 289; Treponema crocidurae McFarland, Pathogenic Bacteria and Protozoa, 2nd ed., 1933, 136) From a shrew-mouse, Crocidura stampfiti, in Senegal Transmitted by Ornithodoros erraticus

Spirochaela clenocephali Patton. (Patton, Ann Trop. Med. and Parasitol., 8, 1912, 357; Treponema clenocephali Ford, Textb of Bact, 1927, 989) Parasitie in the digestive tract of the larvae of the Indian cat-fles, Cienocephalus felis.

Spirochaeta cubensis Hoffman. (Sanidad y Beneficienca Boletin oficial, Havana, 28, 1923, 76.) From the feces of

Hyla septentrionalis.

Spirochaeta culteis Jaffé. (Jaffé, Arch.

1. Protistenk., § 1907, 190; Spironman culteis Cross, S. (act. f. Bakt., I Abt., Orig., 65, 1912, 87; Entomospira culteis Enderlein, Sitzungsber. Ges. Naturf. Freunde, Berlin, 1917, 313; Spiroschaudinnia culteis Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 451; Spirillum culteis Pringault, Compt. rend. Soc. Biol., Paris, 84, 1921, 203; Treponema culties Ford, Texth. of Bact., 1927, 989.) Found in the intestines and Malpiphian tubules of mosquito larvae, Culter sp.

Spirochaeta didelphis Vianna, de Figueiredo and Cruz. (Brasii-Medico, 26, 1912, 912.) From the blood of an opos-

sum, Didelphis aurita.

Spirochaeta equi (Novy and Knapp)
Castellani and Chalmers. (Spirillus,
equi Novy and Knapp, Jour. Int. Dist,
3, 9106, 204; Castellani and Chalmers,
Man Trop. Med., 1st ed., 1910, 209;
Man Trop. Med., 1st ed., 1910, 209;
1913, 404; Spironema equi Castellani and
Chalmers, Man. Trop. Med., 2nd ed.,
1913, 404; Spironema equi Noguchi, Jour.
Evp. Med., 37, 1918, 584; Treponema equi
Noguchi, in Jordan and Falk, News
Knowledge Bact. and Immun., 1923, 461.)
From the blood of a horse. May be
identical with Borrelan theilers.

Spirochaeta equina. (Dodd?, Jour-Comp Pathol. and Therap., 19, 1906, 318; quoted from Pettit, Contribution A l'Étude des Spirochétidés, Vanves, II,

1928, 111 )

Spirochaeta eurygyrala Werner (Werner, Cent f. Bakt, I Abt., Orig. 62, 1909, 241; Spironema eurgyratum (sic) Nogueht, Jour. Exp. Med., 27, 1918, 584; Spirochaudinnia eurygyrada Castellani and Chalmers, Man. Trop. Nied, 3rd ed, 1919, 451; Spirillum eurygyrada Castellani lanı and Chalmers, töld., Borrelia eury gyrata Brumpt, Nouveau Traité de Médecine. Paris, 4, 1922, 495; Treponema eurygyratum Brumpt, ibid., 50 ) From the intestinal contents of man-

Spirochaeta exanthematotyphi Futaki (Futaki, Brit Med Jour, Oct 1917; Trepouema exanthematotyphi Savini, Compt rend. Soc Biol , Paris, 88, 1923, 958) Found in the kidneys and urine of cases of exanthematous typhus Non-pathogenic.

Spirochacta febris Chester (Afanassiew, Cent. f. Bakt , I Abt., 25, 1899, 405, Chester, Man Determ, Bact., 1901, 347 ) From a case of recurrent fever

(Neu-Spirochaeta gadi Neumann mann, Ztschr. f Hyg. 64, 1909, 79; Microspironema gadi Duboseq and Lebailly, Compt. rend Acad Sci Paris, 184, 1912, 662, Treponema gadi Duboseq and Lebailly, Arch. zool exper. et génér, 10. 1912, 331; Spironema gadi Ford, Textb of Bact., 1927, 961) From the blood of a sea fish, Gadus minutus

Spirochaeta gallica Couvy and Dujarrie de la Rivière. (Couvy and Dujarne de la Rivière, Compt rend Soe Biol . Paris, 81, 1918, 22, Treponema gallicum Brumpt, Nouveau Traité de Médecme, Paris, 4, 1922, 500 ) From the blood of trench fever patients

Spirochaeta gangraenae careinomatosae Hoffmann, (Berl klin Wochuschr, 42, 1905, 880.) From malignant tumora.

Spirochaeta gangraenosa nosocomialis Róna (Róna, Verhandl d deutsch dermat Gesellsch , 9, 1907, 471, Treponema gangraenosa nosocomialis Noguelia, Jour Exp Med , 16, 1912, 261 ) From ulcers of the genital region.

Spirochaeta hacmophilus Trosier and Sefferlen, (Ann Inst Past, 58, 1937, 233 ) From a child with intestinal trou ble and continuous fever

(De Spirocharta hispanica de Buen Buen, Ann Parasitol., 4, 1926, 185; Treponema hispanicum Nogueba, in Jordan and l'alk, Newer Knowledge Bact, and 1mmun , 1928, 481 , Spirochaeta marocanum Nicolle and Anderson, Compt. rend Acad Sci Paris, 187, 1928, 747; Amer. Med. Assoc, 49, 1907, 198 8;

Spirochaela hispanicum var. marocanum Nicolle, Anderson and Colas-Belcour, Arch. Inst Past Tunis, 18, 1929, 343; Treponema hispanicum var marocanum Gay et al , Agents of Disease and Host Resistance, 1935, 1974; Borrelia hispanicum Steinbaus, Insect Microbiology. 1916, 453 ) The cause of Spanish and Moroccan relaysing fever Transmitted by Ornithodoros marceanus Not agglutinated by scrum of Borrelia recurrentis. Pathogenie for man laboratory animals

Spirochaeta intestinalis Mache and Carter (Maefie and Carter, Ann Trop Med and Parasitol , 11, 1917, 79, Treponema intestinale Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 505 ) From human feces.

Spirochaeta zonessi Dutton, Todd and Tobey (Dutton, Todd and Tobey, Jour Med Res, 15 (N.S 10), 1906, 491; Spironema jonesis Ford, Textb of Bact. 1927, 964 ) From the blood of an African mudfish, Clarias angolensis

Spirochaeta lagopodis Pantham. (Fantham, Proc. Zool, Society, London, 1910. 692, Spironema lagopodis Noguehi, according to Pettit, loc. cit ) From the blood of the grouse, Lagonus sections. Spirochaeta leucotermitis Hollande.

(Arch zool expér et gén, 61, 1922, 23 ) From an insect. Leucotermes lucifuque. Spirochaeta lorati l'antham. (Proc. Zool Society, London, 1919.) From the intestinal contents of the grouse, Lagonus scoticus

Sperochaeta lowenthali Besson son, p. 736, according to Ford, Textb. of Bact, 1927, 1001.) From malignant tumors

Spirochaeta lutrae Prowazek. (Prowazek, Arb. kawerl Gesundheitsamte, 26, 1907, 31 , Spiroschaudinnia lutrae Castellani and Chalmers, Man. Trop. Med . 2mlel , 1913, 401; Spironema lutrae l'ord. Textb of Bact., 1927, 961.) From the bleed of an otter, Latra sp.

Sperochaeta lymphaticus Proceelur and White. (Proceeder and White, Jour. 1925, 306.) From the intestines of frogs, Rana lemporaria.

Spirochaeta tenuis Gerber. (Gerber, Cent. f. Bakt., I Abt., Orig., 50, 1910, 508; Treponema tenue Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 514.) May be identical with Spirochaela dentium or with Borrelia vincentii.

Spirochaeta termitis (Leidy) Dobell. (Vibrio termitis Leidy, Jour Acad. Nat. Sci., Phila., 2nd Ser., 8, 1891, 441; Spirachaeta minei Prowazek, Arch. f Schiffsu. Tropenhyg., 14, 1910, 297; Dobell. Spolia ceylanica, 3, 1910, 78; Treponema minei Dobell, ibid ; ? Spirochaete grassii Doffein, Prob. der Protistenk., 2, 1911, 17: Spirochaeta grasmi Döflein, Die Natur der Spirochaten, Jena, 1911: Treponema termitis Dobell, Arch. f. Protistenk., 28, 1912, 117; Entomospira grassii Enderlein, Sitzungsber. Ges. Naturf. Freunde, Berlin, 1917, 313; Cristispira termitis Hollande, Arch. Zool. Exper. et Gén , 61, 1923, N. and R , 25; Treponema grassi Ford, Textb. of Bact., 1927, 988.) From the intestines of Termes lucifugue and Calotermes spp.

Spirochaeta tropidonoti Dobell. (Dobell, Spolia ceylanica, 7, 1911, 65, Spironema tropidonoti Ford, Textb of Bact., 1927, 962.) Isolated once from the blood of a snake, Tropidonotus stolatus, in

Cevlon.

Spirochaeta urethrae Mache. (Mache. Ann. Trop. Med. and Parasitol , 10, 1916, 305 : Sproschaudinnia grethrae Castellani and Chalmers, Man Trop Med , 3rd ed . 1919, 451; Treponema urethrae Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 514.) From the urine of Gold Coast natives. Causes acute arthritis

Spirochaeta usbekistanica Pickoul. (Russ. Jour Trop Med , 6, 1928, 612 ) From cases of relapsing fever in Bokhara

Spirochaeta vespertitionis (Novy and Knapp) Castellani and Chalmers (Spirillum respertitionts Novy and Knapp, Jour Inf. Dis , 3, 1996, 291, Castellana and Chaimers, Man Trop Med , 1st ed , 1910, 309; Spiroschaudinnia vespertitionis Castellans and Chalmers, Man Trop.

Med., 3rd ed., 1919, 451; Spironema vespertitionis Ford, Textb. of Bact., 1927, 961.) From the blood of a bat, Vespertelio Luhlii.

Spirochuela vincenti var. bronchiglis Delamare. (Compt. rend. Soc. Biol.,

Paris, 90, 1924, 611.)

Spirochaeta ziatogorovi Yakimoff. (Bull. Soc. Path. Exot., 14, 1921, 532) From feces.

Spirochaele exanthematica Lewascheff. (Cent. f. Bakt., I Abt., 18, 1895, 133) From the blood in cases of typhus fever, Spirachaete forans Reiter, (Reiter, Deutsch, med. Wochnschr., No. 50, 1916, 10; see Cent. f. Bakt., I Abt., Orig., 79, 1917, 176; Treponema forans Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 500; Spirochaeta forans Pettit, Contribution à l'Étude des Spirochétidés, Vanves, II, 1928, 164.) From the blood in a case of articular rheumstism. Not pathogenic for guinea pigs or mice

Spirochaete gracilis Veszpremi. (Veszpremi, Cent. f. Bakt., I Abt., Orig, 44, 1907, 332; not Spirochaeta gracilis Levaditi and Stanesco, Compt rend. Soc. Biol , Paris, 67, 1909, 185 (Treponema levaditii Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 501; Treponema gracile Brumpt, edem); Treponema gracile Ford, Textb. of Bact., 1927, 978) From a gangrenous phiegmon of the mouth. Found in associ tion with fusiform bacilli and therefor may be identical with Borrelia vincentii or Spirochaela dentium or Treponema macrodentium.

Spirochaete repacis. (Quoted from Lehmann and Neumann, Bakt. Ding., 6 Aufl., 2, 1920, 809. ) From the oral cavity. Spironema carrae Ford (Spirochaele (?), Mactic, Ann. Trop. Med. and Parasitol., 8, 1914, 447; Ford, Textb. of Bact.,

1927, 961.) From the blood of a guinea nig at Lagos.

Spironema resperuginis (Gonder) Ford. (Spirochaela resperuginis Gonder, Arb. kais Gesundheitsamte, 27, 1908, 406; Ford, Textb. of Bact., 1927, 961.) From the blood of a bat, Vesperugo kuhlii. Spiroschaudinnia cariae Sangiorgi.

- 39. Pseudomonas ambiaua.
- 40. Pseudomonas sinuosa.
- 41. Pseudomonas cruciviae

cc. Grow poorly or not at all at 37°C.

d. Action on hydrocarbons and cellulose unknown

Pseudomonas rugosa
 dd. Utilize hydcocarbons,

- 43. Pseudomonas desmolyticum.
  - 44. Pseudomonas rathonis.
  - 45. Pseudomonas dacunhae.
- Pseudomonas arvilla
   Pseudomonas salopium,

ddd Utilize cellulose.

- 48. Pseudomonas minuscula.
- 49. Pseudomonas tralucida
- 50 Pseudomonas mira

aaa. Action on gelatin not recorded Produces alcoholic fermentation of

glucose
51. Pseudomonas lindners

 Sea water to brine species. Some species phosphorescent a Gelatin liquefied.

b. Polar flagellate

c From sea water. Not deeply pigmented.

d Nitrites not produced from nitrates.

Pseudomonas membranoformis.
 Pseudomonas marinoglutinosa

dd. Nitrites produced from pitrates so far as known

e. Digest agar.

54. Pseudomonos gelatica.

ee Deposit calcium carbonate in sea water gelatin

55. Pseudomonas calcis.

56 Pseudomonas calciprecipitans eee Causes skin lesions in marine fish.

uses skin lesions in marine fish.

57 Pseudomonas ichthyodermis

cc. Produce highly colored pigments in media containing salt or in heavy brines.

d. Blackens salted butter.

5S. Pseudomonas nigrificans dd. Causes purple discoloration of salted beans.

59. Pseudomonas benerinckii.

ddd. Reddens heavy brines (more than 18 per cent salt).

61. Pseudomonas cutirubra

ecc. Phosphorescent bacteria from decaying fish and crustaceans, and phosphorescent organs of sea animals.

d. Gelatin liquefied.

62. Pseudomonas harreyi.

dd Gelatin not liquefied.
63. Pseudomonas phosphorescens.

64. Preudomonas pierantonii.

Morphologically indistinguishable from Treponema vallidum.

Chltivable under anaerobic conditions in the same medium used for Treponema pallidum.

Habitat: The cause of yaws-tropica frambesia. Patients with the disease give a positive Wassermann test. Prboably transmitted by contact.

3. Treponema microdentium Noguchi. (Jour. Exp. Med., 15, 1912, 81.) From Greek mikros, small and Latin, teeth.

The organism is less than 0.25 micron in thickness in the middle and tapers toward each extremity, which is pointed. The length varies with age but may reach 8 microns and show an average of 14 curves. Sometimes a long, thin flagella-like projection is observed at each extremity.

Growth occurs under anaerable conditions in serum water medium containing fresh tissue. The serum is slightly coagulated and gives off a strong, fetud odor.

Habitat · Normal oral cavity.

 Treponema mucosum Noguchi. (Jour. Exp. Med., 16, 1912, 191; Spirochaeta mucosa Pettit, Contribution à l'Étude des Spirochétides, Vanves, II, 1928, 190.) From Latin, mucous

Spirals: 0.25 to 0.3 by 8 to 12 microns. The number of curves varies from 6 to 8. Both extremities are sharply pointed and often possess a minute curved projection, 2 to 10 microns long.

Cultivable under anaerobic conditioos,

forming mucin. The cultures give off a strong, putrid

odor. Takes the red in Giemsa's stain

Strict anaerobe. Source: From pus in a case of pvorrhoea.

Habitat: Found in pyorrhea alveolaris It possesses pyogenic properties.

Treponema calllgyrum Noguchi. (Noguchi, Jour. Exp. Med , 17, 1913, 96; Spirochaeta calligyra Zuelzer, 1925, in Prowazek, Hand d. path. Protoz., 5, 1931, 1673.) From M. L., with beautiful circles.

Morphology: 0.35 to 0.4 by 6 to 14 mierons, average 9 to 12 microns. Spirals are regular and deep but more rounded than those of Treponema pallidum. The organism is of uniform width until near the extremities which end in sharp points with delicate projections.

Motility: Active, chiefly rotating. Staios reddish-violet with Giemm's

Cultivation: Grows under anaerobic conditions.

Not pathogenic for monkeys or rabbits. Source: From smegma.

Habitat : Lesions and membranes of the pudenda.

6. Treponema genitalis Noguebi (Treponema minutum Noguchi, Jour. Exp. Med., 27, 1918, 671; not Treponema minutum Dobell, Arch, f. Protistenk., 26, 1912. 151: not Treponema minutum Castellani, 1916; Noguchi, Laboratory Diagnosis of Syphilis, New York, 1923, 260; Spirochacta minutum Zuelzer, 1925, in Provazek, Handb. d. path. Protoz., \$, 1931, 1673; Spirochaeta genitalis Séguia and Vinzent, Ann. Inst. Past., 61, 1939, 255 ) From Latin, genital,

Morphology: 0 25 to 0 3 by 3 to 14 microns. Spirals round, regular and shallow. Smaller than Tree onema pallidum and spirals are closer to other.

Motility: Active

Culture: Grows anaerobically and requires fresh tissue

Non pathogenic.

Habitat: Found on male and female genitalia.

Brumpt. 7. Treponema carateum (Treponema de un caso de pinta, Saenz, Grau Triana and Alfonso, Arch. de Med Int., Havana, 4, 1938, 3; Brumpt, Compt. Rend Soc. Biol., Paris, 180, 1939, 912; Treponema herrejoni León y Blanco, Rev. de Med. Trop. y Parasitol., Habana, 6, 1940, 5, Treponema pictor Pardo-Castello, Rev. de Med. Trop. y Parasitol

(Sangiorgi, Pathologica Rivista, 5, 1913, 423, Spirochaeta caviae Hindle, Med. Res. Council Syst. of Bact., 8, 1931, 174.) From the blood of a guinea pig

Spiraschaudinnia mitis Castellani and Chalmers. (Castellani and Chalmers, Man. Trop Med, 3rd ed., 1919, 451; Treponema mite Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 506.) From urine in mild cases of camp jaundice.

Probably not puthogenic.

Treponema lincola (Donné) Brumpt. (Vibrio lincola Donné, Recherches Microse, Nature d. Mucus des Organs Genitournaires, Paris, 1837; Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 505) From secretions of the genitalea.

Genus II. Treponema Schaudinn.



in acute, regular or irregular spirals Terminal filament may be present. Some species stain only with Giemas's stain. Weakly refractive by dark field illumination in living preparations. Cultivated under strictly amerobic conditions. Pathogenic and parasitic for man and animals. Generally produce local lesions in tissues.

and parasitic for man and animals Generally produce local lesions in tissues.

The type species is Treponema pallidum (Schaudina and Hoffmann) Schaudina.

1 Treponema pallidum (Schaudinn and Hoffmann) Schaudinn (Sprochaete pallida Schaudinn and Hoffmann, Arb. Ausserl Gesundheitsamte, 22, 1905, 523, Schaudinn, Deutsche med. Wochnschr, 51, 1905, 1725; Spironema pallidum Vullemm, Compt. rend Acad Sci. Paris, 140, 1905, 1567, Microspironema pallidum Stules and Piconder, Amer Med., 10, 1905, 305, Tripanosoma luis Krzystalowicz and Stedlech, 1905, eea abst. in Bull. Inst. Past., 4, 1906, 204; Spirochaeta pallida Hoffmann and Prowasck, Cent. I Bitt., I Abt., Orlic, 41, 1906, 741.) From Latin. pale.

Morphology: Very fine protoplasmie spirals 0.25 to 0.3 by 6 to 11 microns South amplitude: 1.0 micron, results

Spiral amplitude: 10 mieron, regular, fixed

Spiral depth 0.5 to 1.0 micron. Terminal spiral filament present

Weally refractive in living state by dark field illumination. May appear as a series of bright date or string of redam leads with proc dark field illumination. Staming Stam with difficulty except with German's stain by which they appear pink or now. Appear black with silver impregnation methods

Motility · Sluggish, drifting motion, stiffly flexible, rarely rotating

Trypsin digestion Resistant for many days

Bile salts (10 per cent): Disintegration

Saponin (10 per cent) Broken up in

Cultivation: With infficulty under strict anaerohosis in ascitic fluid with addition of fresh rabbit kidney.

Habitat The cause of syphilis in man. Can be transmitted experimentally to anthropoid apes and rabbits

2 Treponema pertenue Castellani, Castellani, Jour Trop Med., 8, 1905, 231; Spurchaeta pertenus Castellani, Jour Crojon Branch Brit Med. Assoc., June, 1905, Spurchaeta pelidudia Castellani, Brit Jour. Med., 2, Nov., 1905, 1330; Spurchaeta pertenus Lehmann and Neumann, Bakt Durg., 5 Aufl., 2, 1912, 677; Spurmeran pertenus Gross, Archiv f. Prolisteni, 24, 1912, 115; Treponema pelidudum Bumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 508) From Latin, very fine.

Habana, 6, 1940, 117; Trepanema pintae Curbelo, Elementos de Bacteriología Médica, 1941, 34.) From carate, spotted sickness

Description taken from León y Blanco (loc cit.) Cylindrical 0 25 to 0 30 by 7.8 to 36 8

microns, average length 178 microns With sharp-pointed ends.

Spiral amplitude .1 micron, regular Spiral depth 08 to 10 micron.

Number of waves, 6 to 27, according to length Ten to twelve (Brumpt, lac at 1)

Actively motile. At times undulating or creeping movements are shown

Staining reactions Readily takes silver impregnations, Giemsa's stain, carbolfuchsin and gentian violet

Saponin (10 per cent) Disintegrates in six hours at room temperature. Same result with sodium taurocholate (10 per cent) and with bile. Distilled water: Produces swelling

Loses motility on heating for 15 minutes at 50°C or for 3 hours at 41°C.

Wassermann, Kalin and Meinicke reactions positive

Ilas not yet been cultivated artificially Experimental transmission unsuccessful so far.

Source From the border of cutaneous lesions of persons having pinta (spotted sickness)

Habitat The cause of pinta (or existe) Common in Mexico and Colombra. Also found in other morthern emintres of South America, in Central America and the West Indies. Bare in Culta. Posubly found in other tropical regions of the world.

8 Treponema cuniculi Noguchi (Sprachotz) parolari camenti Jakoba dad, Bermatol Webnecht, 74, 1939, 590, Noguchi, Jour Amer Med Assoc, 77, 1921, 2332, also see Noguchi, Jour Lay Med, 33, 1922, 333, Treponema polludom var cuniculi Nitrophesh, Cent f Bakt 1 Ma. Orag, 85, 1921, 233, Sprachada cuniculi Sershulti, Mine and Jeuen.

Compt rend Soc. Biol, Paris, 85, 1921, 51; Spirochaela pollida var. cumculi Zuelter, 1925, in Prowatek, Handb. d. path Protoz., 3, 1931, 1765; Spirochaela parolus Pettit, Contribution à l'Étude des Spirochéulés, Vanves, 11, 1928, 91; Spirochaela parolus-cuniculi Hindle, Med Res. Council Syst. of Baet., 8, 1931, 187.) From Latin, rabbit.

Description from Noguchi (loc. cit). Closely resembles Trepanema pallidum, but longer.

Width 0 25 mieron; length 10 to 16 mierons; long specimens up to 30 mierons frequent.

Spirals 8 to 12 in number, regular, ileep. Spiral amplitude 1 to 1 2 microns

Spiral depth 0 6 to 1.0 micron.

Delicate terminal filament at one,

sometimes both, ends

Often forms entangled masses of long threads, occurs sometimes in a stellate arrangement Staining properties same as for Trepo-

nema pullidum. Both readily stained by ordinary basic analine dyes when fived in a buffered formalileby desolution.

Wassermann reaction negative

Pathogenesis. Disease transmissible to healthy rabbits, producing rapular lesions in the genitoperineal region. Not pathogenic for monkeys, nuce or guinea 18gs.

Source · I'rom lesions in the genitoperineal region of five rabbits

Habitat The cause of rabbit spiro-

Appendix: Many of the species in this appendix are so madequately described that it is not certain that they belong in this group

Microspirionema Irgeri Dilascel and Lebally (Duloscu and Lebally, Compit rend sted Sci Paris, 134, 1912, 662, Treponema Irgeri Zuelter, 1925, in Provants, Hardb el jath Protoc., 5, 1931, 1681.) Truna fish, Bor boops.

Spirochaeta microgyratu Lieno utled. (Lienventled, Berl Min. Wochnschr., 43, 1906, 283; Spironema microgyrata Nigu1928, 911.) Pathogenic. Cause of a disease in sheep.

Treponema querquedulae Lebailly. (Compt. read. Soc. Biol., Paris, 75, 1913, 389.) From caeca of hirds. Named for the teal, Querquedula querquedula.

Treponema rhinopharyngeum Brumpt. (Treponema rhinulum Castellani, 1916; Spiroschaudinnia minuta Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 1831; Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 514) Fromman in cases of rhinopharyngitis. Probably a synonym of Spirochaela gracilis.

Treponema rigidum Zinsser and Hopkins (Jour. Bact, 7, 1916, 489.) From the tissues in five different strains of rabbit syphilis. Probably a synonym of Treponema cunculi

Treponema spermiformis Duboscq and Grassé (Arch. Zool. Expér et Gén, 66, 1927, 483) From the rectum of a termite, Glyptotermes tridipennia

Treponema squatarolae Lebailly. (Compt. rend Soc. Biol., Paris, 75, 1913, 359.) From the casecum of a birtl, Squatarola sountarola.

Treponema stylopygae Dobell. (Dobell, Arch. I. Protistenk, 28, 1912, 117. Spirochaeta stylopygae Zuelzer, 1925, in Prowazek, Handlo d. path. Protoz., 3, 1931, 1685.) From the intestines of the cockreach, Stylopyga crientals.

Treponema tricalle Cohn, (Cohn, 1872, quoted from Castellani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 414.)

Treponema triglae Duboseq and Lebailly. (Arch. Zool. Expér et Gén., 10, 1912, 331.) From the rectum of a fish, Trigla lucerna.

Treponema tropiduri Neiva, Marques da Cunha and Travassus. (Mem. do Inst. Oswaldo Cruz. 6, 1914, 180.) From the blood of a South American lizard, Tropidurus torquatus.

The following species are listed in the index of Castellani and Chalmers, Manual of Tropical Medicine, 2nd ed., 1913, 1715-1719, but are not mentioned in the text (pp. 130-141): Treponema boridae, T. camedidae, T. candea, T. feldae, T. hippopolami, T. reptila, T. rhinaceri, T. sclachi, T. suidae, T. ungulata and T. ungulata

## Genus III Leptospira Noguchi. (Jour Pap Med , 25, 1917, 753.)

Finely coiled organisms 6 to 20 nucrons in length Spirals 0.3 mi ron in depth and 0.4 to 0.5 micron in amplitude. In liquid medium one or both end, are bent into a semicircular hook each involving 1 to 1 of the organism. Spiraling movements in liquid and vermiform in semisolid agar, forward or backward Seen in living preparations only with dark field Stain with difficulty except with Giemsa's stain and silver impregnation? Require oxygen for growth.

The type species is Leplospira icterohaemorrhagiae (Inada and Ido) Nogurhi

1. Leptospira icterohaemorinagiae (Inada and Ido) Noguchi Epirochaeta citerohaemorinague Inada and Ido, Tokyo Ijishinski, 1915, Inada, Ido, Hoki, Kaneko and Ito, Jour Evp Med. 23, 1916, 377; Spirochaeta icterogenes Uhlenhuth and Fromme, Med. Klin, 11, 1915, 1202, Spirochaeta nodosa Huchuer and Reiter, Deutsch. med. Wochnschr, 41, 1915, 1275; Noguchi, Jour. Exp Med., 25, 1917,

755, Spirozchaudinnia ieterohaemorhogat Castellani and Chalurers, Man Trop. Med., 3rd ed., 1919, 47; Treponema veterogene Gonder and Gross, Arch. f. Prolistenk., 39, 1919, 62; Spirochaeti letero-haemorrhagica (sic) Lehmann and Neumann, Bakl. Diog, 6 Aufl. 4, 1820, 810; Treponema tetero-hemorragica (sic) Brumpt, Nouveru Traité de Mélceine, Paris, 4, 1922, 501; Treponema nodosum

180, Spirochaete dentienta Flugge, Die Mikroorganismen, 2 Aufl , 1886, 390; Spirochaete dentium Miller, Microorganisms of the Human Mouth, Philadelphia, 1890, 80, Spirillum dentium Sternberg, Manual of Bact , 1893, 691; Spirochacta dentium Migula, in Engler and Prantl, Die natürl Pflanzenfam., 1, 1a, 1895, 35, Spirochaeta denticola Arndt, according to Hoffmann and Prowazck, Cent f. Bakt, I Abt, Orig., 41, 1906, 819; Dobell, Arch f Protistenk , 26, 1912, 117, Spirouema dentium Gross, Cent f Bakt., I Abt, Orig, 65, 1912, 83, Spirochaela dentinum McFarland, Pathogenic Bacteria and Protozoa, 7th ed. 1912, 516, Treponema microfentrum Noguchi, Jour Exp. Meil , 15, 1912, 81. Spirochneta orthodonia Hoffmann, Deutsch med Wochuschr , 46, 1920, 257, Spirochaela microdentium Ifem, Ichr il Bakt , 6 and 7 Aufl , 1922, 477, Treponema denticola Brumpt, Nouveau Traité de Medecine, Paris, 4, 1922, 497, Treponema orthodoutum Noguchi, in Jordan and Falk, Newer Knowledge Bact and Immun. 1928. 481: Treponema dentium-stenoagratum Pettit, Contribution & l'Étule des Spirochétidés, Vanves, 11, 1928, 210 ) The smallest of the mouth spirochaetes Non pathogenie This term probably includes several morphologically similar species which have not as yet been suffi eiently characterized

Treponema drosophilae Chatton (Compt remi See Bool, 73, 1912, 212) From Drosophila confusa See to thirty microns in length, tapers at both ends, four spirmls, movement helicoidal

Treponema gallicolum Lebailly (Compt. rend Soc Biol , Paris, 75, 1913, 389) From the caccum of the ben, Gallus sp

Treponena hill Dilayseq and Grasses (Compt rent. Soc Biol, Paris, 94, 1926, 31; Arch Zool, Expér et Gén, 65, 1927, 481) From the surface of the body of a flagellate, Derezcorina hills, and in the intestine of a termite, Glyptoternes tradipennis A very small organism.

Treponema intermedium Pabell. (Mittelformen, Lühe, Handb d Tropenkrankh , 5, 1906 , see Hoffmann and Prowazek, Cent f. Bakt , 1 Abt , Orig., 41, 1906, 819, Dobell, Arch f Protistenk., 26, 1912, 117, Treponema macrodentium Noguchi, Jour. Exp. Med , 15, 1912, 81; Spirochaeta media oris Hoffmann. Deulsch med. Wochnschr . 46, 1920, 257: Treponema medium Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 505: Spirochaeta intermedia Pettit, Contribution à l'Étude des Spirochétidés, Vanves, II, 1928, 146, Spirochaeta macrodentium Pettit, ibid . 182. Spirochaeta media and Spironema media l'ettit, ibid , 210.) The middle-sized spirochete of the mouth

Treponema lan: Lebailly. (Compt. rend Soc Biol, Paris, 75, 1913, 389) Found in the caccum of birds, also in the guinea-pig. Named for one of the birds, Larus radbundus.

Treponema minitum Dobell. (Treponema sp. Dobell, Quart. Jour. Microsc. Sci. 52, 1908, 121, Dobell, Arch. f. Protestenk, 26, 1912, 151, not Treponema minitum Natellani, 1916, not Treponema minitum Naguchi, Jour. Exp. Med., 27, 1918, 671. Spirochaeta minitum Zuelzer, 1923, in Pronatck, Handb. d. path. Protor. 5, 1931, 1682) From the large Intesluces of teads. Bute videous.

Treponema para un Dobell (Dobell), Arch f Protistenk, 26, 1912, 117; Spirachacta para un Zuelzer, 1925, In Prowazek, Handh d path Protoz 3, 1931, 1655.) From the intestime of the cockmach, Siylopuya (Matta, Perplaneta) orientalis. Very small organism

Treponema paionis Dubosca and Letailly (Arch Zool Pyper et Gén., 10, 1912, 331.) From the intestine of the blenny, Blennius paro

Treponena perezia Duloseq and Lelauliy, Arch. Zool Eupfe et Gén, 10, 1912, 331; Sprochaeta perezia: Hindle, Med Res Councal Syst of Bact, 8, 1931, 190). From the blord of a marine fielt, Lepadogaster bimaculatus.

Treponema podorus Ludovic and Blaizot (Compt. rend Acad. Sci. Paris, 187,

Morphologically indistinguishable from Leptospira icterokaemorrhagiae.

Cultivation : Same as Leptospira icterohaemorrhagiae.

Immunology: Some exoss-reaction with Leptospira iclerohacmorrhagiae, but specific in higher dilutions of immune serum.

Source: From blood of dogs.

Habitat: A natural parasite of dogs. Causes a chronic disease of old dogs characterized by uremia, not jaundice. Fatal in 80 per cent of those infected. No intermediate host known. Probably transmitted by direct contact; possibly by healthy carriers.

Appendix: The species listed below are inadequately described and may be identical with those described in full.

Leptospira aqueductum (eic) Ford. (Spirochaein pseudoicterogenes aquaeductuum Uhlenhuth and Zuelzer, Cent. f. Bakt., I Abt , Orig., 85, 1921, \*150; Ford, Textb. of Bact., 1927, 998) From fresh water of aqueducts Probably a synonym of Leptospira bifleza.

Leptospira osthenoalgiae Carbo-Noboa. (Bull. Inst. Past , 22, 1924, 898.) From blood, urine and organs of persons having

dengue.

Leplospira outumnalis Topley and Wil-(Akiyami Type A, Koshana, Shiwozawa and Kitayama, Japan. Med. Wld., 4. 1921, 268; see also Jour Exp. Med., 42, 1925, 873; Topley and Wilson, Princip Bact. and Immun , 1st cd , 2, 1931, 1202; Spirochaeta autumnalis A, quoted from Hindle, Med. Res. Council Syst of Bact., 8, 1931, 312; Spirochaeta autumnatis Hindle, ibid.) The cause of akiyami or harvest sickness in Japan. May be identical with Leptospira ictero haemorrhagiae.

Leptospira batarrae (1925, quoted from Gispen and Schuffner, Cent. f. Bakt., I Abt., Orig , 144, 1939, 427.) From a case of fever in the Dutch East Indies. Probably a synonym of Leptospira hebdomadis.

Leptospira biliohemoglobinuriae (Blanchard and Lefrou) Noguchi chaeta bilio-hemoglobinuriae Blanchard

and Lefrou, Compt. rend. Acad. Sci , Paris, 175, 1922, 602; Noguchi, in Jordan and Talk, Never Knowledge Bact. and Immun , 1928, 190.) From cases of blacknater fever.

Leptospira bonariensis Savino and Rennella. (Rev. Inst. Bact. "Dr. Carlos G. Malbram", 12, 1944, 182.) From gray rats.

Leptospira bot is Noguchi. (New York State Med. Jour., 22, 1922, 426.) From

the gastric mucosa of the ox.

Leplospira couryi Gomes de Faria. (Compt. rend. Soc. Biol., Paris, 90, 1924, 55; Spirochaela couryi Hindle, Med. Res. Council Syst. of Bact., 8, 1931, 317.) From the blood of persons having dengue.

Leptospira dentale Perrin. (Rev. Mex. de Biol., 2, 1922, 171.) Found in the pus

of bucco-maxillary gangrene.

Leptospira grippo-typhosa Topley and Wilson. (Topley and Wilson, Princip. Bact. and Immun., 2nd ed., 1936, 728; Spirochaela dmitrori Rimpau, Schlossherger and Kathe, Cent. f. Bakt., I Abt Orig , 141, 1938, 320.) The cause of swamp lever in Europe. Probably synonymous with Leptospira hebdomadis. Also see Baschenin, Cent. f. Bakt, I Abt , Orig , 115, 1929, 438 and 450; Dinger and Verschaffelt, Ann. Inst. Past, 45, 1930, 396.

Leptospira haemoglobi niriae Schaffnet. (Gencesk. Tijdschr. Nr Indie, 58, 1918, 352, Spirochaela haemoglobinuriae Hindle, Med Res. Council Syst. of Bact , 8, 1931, 314.) From the blood of a Javanese patient suffering from an attack of black-

water fever. rcterohemoglobinuriae Schüffner. (Schuffner, Geneesk. Tijd-Leplospira schr. v Ned. Indie, 58, 1918, 352, according to Pettat, Contribution à l'Étude des Spirochétidés, Vanves, II, 1928, Spirochaela icterohemoglobinuriae Schuffnet, Mededeel. Burgerl. Geneesk. Dienst in Nederl. Indië, 58, 1918, 7 (according to Blanchard and Lefrou, Compt. rend. Acad Sci , Paris, 175, 1922, 602); Treponema icterohemoglobinuriae Brumpt, Brumpt, ibid , 508, Leptospira reterogenes Ford, Textb of Bact., 1927, 934; Leptospira nodosa Ford, ibid., 933.) From Greck icterus, jaundice and hemorrhagiae, bleeding.

Morphology: 0.25 to 03 by 6 to 9 microns and occasionally 20 to 25 mierons

Spiral amplitude, 0.4 to 0.5 mieron, regular, rigid.

Spiral depth: 0 3 micron, regular.

Waves; One or more gentle waves throughout entire length, When in liquid media, one or both ends may be semicircularly hooked, while in semisolid media the organism appears serpentine,

waved or bent. Very active flexibility. Terminal filament and flagella absent. Body stains reddish by Giemsa's stain Bile salta (10 per cent): Easily dis-

haylos Saponin (10 per cent). Completely re-

Cultured castly in medium containing 10 per cent rabbit serum, 02 per cent agar, alight amount of hemoglobin in salt or Ringer's solution. Does not grow in surface rolonies

Temperature range: 25° to 37°C Remains alive longer at 25°C.

l'athogenic for guinea pigs and deer-Direc

llabitat The cause of infectious jaundice in man (Weil's disease) Found in the kidneys, urine and blood of wild rats No insect vector known Found free living in water and alime (in mines)

2 Leptospira hebdomadia (ldo ct al.) (Spirochaeta nanukayamı Noguchi Ido, Iloki, Ito and Wam, Nippon Gakkar Zasshi, 5, 1917, No. 5, Spirochaela hebdomades Ido, Ita and Wani, Jour Exp. Med., 28, 1915, 435, Spiroschaudinnia hebdomadıs Castellanı and Chalmers, Man Trop Med , 3rd ed , 1919, 448, Noguchi, Jour Exp Med , 30, 1919, 17; Treponema hebdomadia Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 501.) From Latin, seven days.

Morphologically indistinguishable from

Leptospira icteroheamorrhagiae but can be distinguished scrologically.

In man causes less is undice than Leptoapira ieterohaemorrhagiae and is never fatal.

Identical with Type B, Leptospira aufumnalis

Slightly pathogenic for young guinea

Is carried by the field vole (Microtus montibelli)

Habitat: Cause of seven-day fever or gikiyami in Japan

3 Leptospira biffexa (Wolbach and Binger) Noguchi. (Spirochaeta bifleza Wolbach and Binger, Jour, Med. Res , 50, 1914, 23; Noguchi, Jour Exp. Med., 27. 1918, 585; Spirochaela pseudo-icterogenes (aquatiles) Uhlenhuth and Zuelzer, Cent. f. Bakt., I Abt., Orig , 85, 1921, 141; Spirochaeta pseudoicterogenes Uhlenhuthand Zuelzer, Klin. Wochnschr., 1, 1922, 2121; pseudo-icterohemorrhagige Spirochaeta Vinzent, Compt. rend. Soc. Biol . Paria. 95, 1926, 1472; Leptospira pseudoictero. genes Noguchi, in Jordan and Falk, Newer Knowledge Bact, and Immun , 1928, 461.) From Latin, doubly bent,

Size: 02 to 025 by 5 to 7 microns with tapering ends Spiral amplitude 0.2 to 025 micron. Will pass through an 1.5 candle filter.

Wases 22 to 30 in number.

Stains: Best results with Giemea's stain

Culture Can grow in distilled water plus 01 per cent potassium nitrate. Habbut serum in distilled water is best medium

Optimum temperature 20°C.

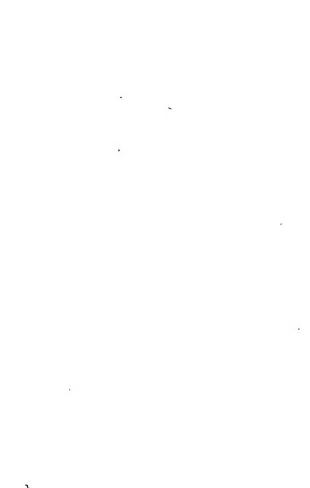
Antigenically distinct from Leptospira scterahaemarthagiae.

Not rethigenic

Source From tap water, ponds and tools in Berlin

Habitat · Fresh water.

4 Leptospira canicola Okell et al. (Okell, Dalling and Pugh, Vet. Jour , 81, 1925, 3) From Latin, dog-dweller.



Nouvesu Traité de Médecine, Paris, 4, 1922, 501) From the blood in a case of blackwater fever.

Leptospira interrogans (Stimson) Naguchi (Spirochaeta interrogans Stimson, U S Public Health Rept , Part 1, 22, 1907, 541, Leptospira icteroides Noguchi, Jour Exp Med , 29, 1919, 581; Treponema interrogans Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 505, Treponema icicroides Brumpt, ibid ; Spirochaela reterordes Lehmann and Neumann, Bakt Ding , 7 Aufl , 2, 1927, 576, Noguchi, in Jordan and Falk, Newer Knowledge Bact and Immun , 1928, 454 ) Noguela (1928) regards this species as plentical with Leptospira icterohaemorrhamae

Leplospira petitis (Teasinger) Hindle (Spirochaele petitis Feasinger, Ann de Méd. 3, 1918, 195, Treponema petitis Brumpt, Nouveau Traité de Médeeine, Paris, 4, 1922, 510, Hindle, Med Bess Council Syst. of Baet., 3, 1931, 316, Spirochaela petitis Hindle, Jour. Trop Med and Hig, 1922, 301). From utien Merphologically indistinguishable from Leptospira eterochaemershagiae.

Leptapira pyrogenes Vervoort. (Ver voort, Geneesk, Tujsker v. Ned. Indis, 63, 1923, 800, Spirochaela febrils Vervoort, Rep. Fis Last Assoc Trop Med., London, 1923, 683; Spirochaela pyrogenes Ilindia, Med Res Council Syst of Bact, 8, 1931, 341 v. From the blood of persons suffering from dengue like fevers in Sumatra Pathogenic

Leptospira saxkoebing Petersen (Acts Path et Microbiol. Scand, 21, 1911, 165) A new scrological type.

Leptospira salina Fonl (Spirochaeta pseudoicterogenes salina Uhlenhutli und Zuelzer, Cent. f. Bakt , f Abt , Orig , 85, 1921, \*150, Ford, Textb. of Bact , 1927, 998 ) From salt water.

Leplospira trimerodonta (Hoffmann) Noguchi (Spirochota trimerodonta Hoffmann, Deutsch med. Wochnschr.; 46, 1920, 237, Leplospira dentum Hoffmann, ed., 625; Leplospira buccilis Fostana, according to Fettit, Contribution Ji Fitude des Spirochétudes, Vanves, II, 1928, 232; Noguchi, in Jordan and Falk, Newer Knowledge Rart, and Immun, 1923, 461) 1 From the ordi cavity, May be synonymous with Leplospira seterohammenhamse

Spirochaela anthropopithes Wilbert and Delorme (Ann. Inst. Past., 41, 1927, 1147.) Pathogenie for chimpanzees in French Guinea Probably identical with Leplospira felerohaemorrhagiae.

Spirochecia elusa Wolbach and Binger (Wolbach and Binger, Jour Med Res, 59, 1914, 9, Treponema elusum Bergey et al, Manual, 1st ed, 1923, 423) From pond water Not pathogene For a description of this species, see Bergey et al., Manual, 5th ed, 1929, 925.

Spirochaela telero-uraemia can'i Klarenbeek (Tijdschr Diergeneesk., 55, 1928, 227) From the kidneys of dogs. Pathogeme for gumen pigs. May be synonymous with Leplospira telerohaemorthanas or L cantella.

Spirochaeta pseudohebdomadis Zuelzer. (1925, in Pronazek, Handh d. path. Protaz , 5, 1931, 1971) Protably identical with Leptorpira hebdomadis

Spirochaeta trimeres Hoffmann, (Deutsch med Wochnschr, 49, 1920, 277.) From the oral exity. May be synonymous with Leptospira trimerodoute

- III. Plant pathogens, causing leaf spot, leaf stripe and similar diseases.
  - Green fluorescent pigment produced.
    - a. Gelatin liquefied.
      - b. Acid from sucrose.
        - c. Nitrites produced from nitrates.
          - 65. Pseudomonas martuniae.
          - 66. Pseudomonas striafaciens.
        - 67. Pseudomonas tomato. cc. Nitrites not produced from nitrates.
        - - d Growth in 5 per cent salt.
            - 68 Pseudomonas acerus
              - 69. Pseudomonas anaulata.
              - 70. Pseudomonas aptata.
              - 71. Pseudomonas primulae.
              - 72. Pseudomonas viridilivida.
          - dd. No growth in 5 per cent salt
            - e. Beef peptone agar turns brown. 73. Pseudomonas delphinii.
              - ce. Beef peptone agar uncolored.
                - 74. Pseudomonas berberadis.

                  - 75. Pseudomonas coronafaciens.
                  - 75a. Pseudomonas coronafacions var. atropupurea.
                  - 76. Pseudomonas lachrumans.
                  - 77. Pseudomonas maculicola.
                  - 78. Pseudomonas marginata.
                  - 79. Pseudomonas medicaginis.
                  - 79a. Pseudomonas phaseolicola.
                  - 80. Pseudomonas pisi.
                  - S1. Pseudomonas suringae.
          - ddd. Growth in salt solutions not recorded.
            - 82. Pseudomonas atrofaciens.
            - 83. Pseudomonas cumini.
            - 84. Pseudomonas desaiana.
            - 85. Pseudomonas erodii.
            - Pseudomonas apii.
            - 87 Pseudomonas matthiolae.
            - 88. Pseudomonas mors-prunorum.
            - 89. Pseudomonus rimaefaciens.
            - 90. Pseudomonas papulans.
            - 91. Pseudomonas pseudozoogloeae.
            - 92. Pseudomonas tabaci.
        - eec Natrite production not reported. 93. Pseudomonas lapsa.
        - bb. No acid from sucrose.
          - c. Nitrites produced from nitrates.
            - 91. Pseudomonas bowlesiae.
              - 95. Pseudomonas intubi.
              - 96. Pseudomonas marginalis.
              - 97. Pseudomonas selariae.

## SUPPLEMENT NO. 1.

# ORDER RICKETTSIALES

#### ORDER RICKETTSIALES GIESZCZYKIEWICZ.

(Bull. Intern Acad. Polon. Sci., Classe Math. Nat., B(I), 1939, 9-30,)

Small, rod-shaped, occoid, spherical and irregularly-shaped microorganisms which stain lightly with aniline dyes. Cram-negative. Usually not filterable. Outlivated outside the body, il at all, only in living tissue, embryonated eggs or rarely in media containing body fluids. Parasitic organisms intimately associated with tissue cells and crythrocytes, chiefly in vertebrates and often in arthropods which act as vectors. The intracellular parasites of Professo may also belong here. May cause diseases in man or animals, or both.

### Key to the families of order Rickettsiales.

- I. Intracellular parasites, or parasites intimately associated with tissue cells.

  Do not occur in crythrocytes Frequently cause diseases of vertebrates transmitted by arthropod vectors
- Family I Richeltsiaceae, p. 1083.

  II Facultative intracellular or extracellular parasites found characteristically in or on the crythrocytes of vertebrates

  May be transmitted by arthropod vectora.

  Family II Bartonellaceae, p. 1109.
- III. Intracellular parasites found in vertebrate tissues and not timnsmitted by arthropod vectora.

Family III Chlamydozoaceae, p 1114.

### \*FAMILY I RICKETTSIACEAE PINKERTON.

(Pinkerton, Parasitology, 28, 1936, IS6, Rickettsiales Buchanan and Buchanan, Bacteriology, 4th ed., New York, 1938, 49)

Small, often plcomorphie, rod-shaped, ovoid, coccoid and occcus-shaped beterumitie organisms, intimately associated with arthropot tissues, usually in an Intracellular position. Stain lightly with aniline dyes Gram-negative Have not been cultivated to date in cell-free media. May be parasitive to man and other animals causing diseases (typhus and related ills) that are transmitted by arthropoid vectors (fice, fleas, ticks, mites and probably other ectoparasities).

### Key to the genera of family Rickettslaceae.

I Cells rod-shaped, ellipsoidal and coccoid

A Non-filterable.

Genus I Rickettsia, p. 1081.

Filterable.

Genus II Coxiella, p. 1092.

II Cells spherical, occasionally elongated.

Genus III. Cowdria, p. 1091.

<sup>•</sup> Prepared by Dr. Ida A. Bengton (retired), National Institute of Health, Bethesda, Maryland, November, 1916. Through the courtery of Dr. Edward A. Steinlaus much use was made of material from his look, Insect Microbiology, Itlaca, 1916, 763 pp. before it was generally available.

<sup>†</sup> Includes only those reckettsize which have been rather completely studied. For additional rickettsize, see appendix.

## Genus I. Rickettsia da Rocha-Lima.

(Berl. klin. Webnschr., 55, 1916, 567-569.) Named for Howard Taylor Ricketts who lost his life studying typhus fever,

Small, often pleomorphic, rod-shaped to coccoid arganisms occurring intracytoplasmically in lice, fleas, ticks and mites, or sometimes intranuclearly. Stain lightly with aniline dyes. Gram-negative. Nan-filtenable. Have not been cultivated in cell-free media. Parasites of man and animals which are the etiological agents of epidemic typhus, murine ar endemic typhus, llocky Mountain spotted fever, tsutsugamushi disease, rickettsialpox and other diseases.

For reasons that are discussed elsewhere (Bengtson, Jour. Bact., 63, 1947, 325)

the genus Dermocentrozenus has been united with the genus Rickettsia,

The type species is Rickettsia provazekii da Rocha-Lima.\*

### Key to the species of genus Rickettsia.

- I. Louse-borne.
- II. Flea-borne.
- III. Tick-horne.
- IV. Mite-borne.

low

- 1. Rickeltsia prowazekii.
- 2. Rickettnia tuphi.
- 3. Rickettsia rickettsii.
- 5. Rickellsia taulaugamushi.
- 6. Rickeltsia akari.
- 1. Rickettsia prowazekli da Racha-Lima. (da Rocha-Lima, Berl. klin Wehnsehr, 53, 1916, 567; Rickettsia ezanhematolyphi Kodama, Kitasata Arch Exper. Med., 9, 1932, 360, Rickettsia prowazeki var. prowazek Pinkertan, Parasitalogy, 28, 1936, 186; Ruckettsia prowazeki sub-species prowazek Philip, Amer. Jour. Hyg., 37, 1943, 307.) Named for S von Prowazek who lost his life studying typhus fever.

Minute coccoid, ellipsoidal and avaid forms to short rods, sometimes long rods and occasionally filamentaus forms, often in pairs and occasionally in chains. In infected lice the minute coccaid and

naired coccoid forms predominate over the short and long rods and the filamentaus farms which are up to 40 microns in length. Single elements 0,25 by 04 to 0.3 by 0.45 micron Pairs range from 0 25 by 0.7 to 0 3 by 1.1 microns. In yolk sacs the organisms v ry in size from minute coccoid forms in teavily intected tissue to rod forms resembling small bacteria in lightly infected tissue. Within the same smear of infected mammakan cells and in chick embryo tissue the organisms are quite uniform in size and morphology. Occur intracytoplasmically in vascular endothelial cells and in serosal cells. Non-motile.

name was

<sup>\*</sup> The Editors of the Manual follow Recommendation XL of the International Botanical Code (see p. 59) in regard to the endings used for specific names. This calls for the use of the ri ending for epithets taken from the name of a man ending in a co

The organisms are colored purplish with the Giemas stain, the two individuals of a pair being connected by a zone of faintly blue stained material They are colored blue with Castafeda stain (Jour. Inf. Dis., 47, 1930, 416) and bright red against a blue background with Machiavello stain (Rev. Chilena de Hig y Med Prev. 1, 1937, 101) Grammesative

Cultivation In plasma tissue cultures of mammalian cells, in the louse intestine, in modified Maitland media with sad without agar, on chorio-allantoir membrane and yolk sac of chick embryo, the latter being currently the medium of choice.

Optimum temperature 32°C in plasma tissue culture, 35°C in chick embryo

Immunology: Immunity prolonged but may not be complete in man tinguishable from endemic (murine) typhus in cross immunity tests in guinea pigs, but distinguishable from Rocky Mountain snotted fever and other rickettsial diseases in such tests Neutralizing antibodies are found in the scrum of recovered guinea nigs and convalescent humans up to 2 to 3 weeks after defervescence Killed specines produced from infected lice and from infected solk sacs afford a high degree of protection against the disease Ily perimmune antisera for therapeutic use have been pmduced in rabbits by injection with infected yolk sac suspensions and in horses and donkeys with infected mouse lung auspensions

Scrology: Strains from various parts of the world are closely related as determined by complement fixation, are distinguishable from other rickettsiae by agglutnation, complement fivation and precipitin tests; have a common antigenic factor (alkalı stable polyaccharide) with Protus ON19; and have a soluble antigen in yolk culture.

Lethal effect licavily infected yolk sae cultures injected intravenously or intraperitoneally are fatal to white mice in a few hours.

Resistance to chemical and physical agents: Readily inactivated by heat and chemical agents. A temperature of 50°C kills the organism in 15 to 30 minutes, and 0.5 per cent phenol and 0.1 per cent formalin kill the organism.

Pathogenielty: Pathogenie for man, apes, monkeys, gunea pigs, cotton rats, gerhilles, the louse (Pediculus humanus). Inapparent infections occur in white mee, white rats and rabbits A characteristic febrile reaction with no mortality and without testicular swelling occurs in the gunea pig Passage in gunea pigs is accomplished by transfer of blood or brain from infected animals. Causes a febrile dasease with exanthema and high mortality in man.

Source Seen in the blood of typhus patients and in smears of epithelial cells of the intestinal tract of lice feel on typhus rationts

Habitat The body louve (Pediculus humanus var corporis), head louse (Pediculus humanus var capitis) and Pedicanus longiceps The etological agent of epidemic typhus (European typhus, classical typhus, typhus exanithematicus).

2 'Ricketisla typhi (Wollinch and Todd) Philip. (Dermacentrozenus

<sup>\*</sup> Some may regard the himomial Rickettina typhi as invalid because of its previous use by do Amaral and Monteiro for the organizar caving castern Rocky Mountain spitted fever. However, because the himomial Democratizarian typhi Wollach and Todd clevity last priority and because the himomial proposed by do Amaral and Monteiru has never roome into general use. Rickettina typhi Philip has been accepted for use in the Massa of Il Philip's himomial had been rejected, then it would have been increasing to accept Rickettina enacharias Kodama et al. as this appears to have priority over the more generally used Rickettina second. Monteiro—Elatros.

typhi Wolbach and Todd (not Tood), Aon. Inst. Past., 54, 1920, 158; minute intracellular bodies, Mooser, Jour. Inf. Dis., 48, 1928, 261; Rickettsia manchuriae Kodama, Takahashi and Kono, Saikingaku-Zasshi (Jap.), No. 426, 427, Aug. and Sept., 1931; see Kodama, Kono and Takahashi bibliography, Kitasato Arch. Exper. Med., 9, 1932, 95; Richettsia mooseri Monteiro, Mem. Inst. Butantan. 6, 1931, 97 (pub July, 1932), see do Amaral and Monteiro, bibliography, ibid., 7, 1932, 367; Rickettsia exanthematofcbri Kodama, Kitasato Arch Exp. Med., 9. 1932, 360; Rickettsia muricola Monteiro and Fonseca, Brazil Med., 46, 1932, 1032; Richettsia murina and Richettsia fletcheri Megaw, Trans. Roy. Soc. Trop. Med. Hyg., 29, 1935, 105; Richettsia prowazeki var. moosers Pinkerton, Parasitology, 28, 1936, 185; Rickellsia prowazeki aub-species typht Philip, Amer. Jour. Hyg , 57, 1943, 304; Rickettsia typhs Philip, sdem; not Rickettsia tuphi do Amaral and Monterro, Rev Sud. Amér de Méd. et Chieug , 4, 1933, 806.) From M. L. tuphus, typhus.

Resembles Richettsta prowazeku in morphological and staining properties

Non-motile Gram-negative Cultivated in plasma tissue cultive of mammalian cells, to modified Maitland racid mand without agart, in least, in the peratoneal cavity of X-rayed rats, in the lungs of white mice and in white rats following intranasal snoculation, in the lungs of rabbits following intratracheal inoculation, in the chorio-allantoie membrane and the yolk sac of the chick

Optimum temperature 35°C in chick embryo cells.

embryo.

Immunology: Prolonged immunity io man and animals following infection Complete cross immunity between epidemie and endemic typhus in guinea pigs recovered from infections with Rickettsia provazekii and Rickettsiae typhi. No cross immunity between endemic typbus and Rocky Mountain spotted fever, Q fever or tsutsugamushi disease in guinea pigs.

Serology: Distinguishable from the rickettsiae of spotted fever, Q fever and tautaugamushi disease by complement fination, agglutination and precipitin tests, less readily from R. proruzehi by these tests. Has common antigenic factor with Proteus OX19, and soluble antigen in yolk-ase cultures.

Lethal effect: Heavily infected yolk sac cultures injected intravenously or intraperitonically fatal to white mice in a few hours.

Pathogenicity: Pathogenic for man. apes, monkeys, rabbits, guinea pigs, white rate, eastern cotton rat, white mice, gerbilles Other susceptible animals include the woodchuck, house mouse, meadow mouse, white-footed mouse, old-field mouse, cotton mouse, golden mouse, wild rat (Rattus norvegicus), wood rat, rice rat, flying squirrel, gray squirrel, for squirrel, gophers, cotton-tail rabbit, swamp rabbit, chipmunk, skunk, opossum and cat. A characteristic febrile reaction occurs in the guines pig with testicular swelling without ulceration, after intraperitoneal inoculstion. Passage in guinea pigs is accomplished by transfer of testicular washings or blood from inferted animals Cause of a febrile disease with exanthema in man, with low mortality.

Source: Seen by Wolbach and Todd (foc. cit ) in the endothelial cells of the capillaries, arterioles and veins in sections of skin from cases of Mexican typhus (tabardillo). Also described by Mooser (foc. cit.) in sections and smears of the proliferated tunica vaginalis of guines pigs reacting to the virus of Mexican typhus.

Habitat: Infected rat fleas (Xenopsylla cheopis, Xenopsylla astia), infected chicken fleas (Echidnophaga gulinacea) found on wild rats, and the rat louse (Polyplaz spuniosus). Wild rats and field mice act as the reservoir of infection. The etiological agent of endemic (mur ne) typbus which is transmitted to man by the rat flen.

3. Rickettsla rickettsil (Wolbach) Brumpt. (Dermacentragenus rickettsi Wolbach, Jour. Med. Res., 41, 1919-20, 87; Rickettsia rickettsi Brumpt, Précis de Parasitologie, 3rd ed., 1922, 757, Rickettsia braziliensis Monteiro, Mem Inst. Butantan, 6, 1931, 3; \*Rickettsia typhi do Amaril and Monteiro, Rev Sud Amér. do Méd et Chirurg . 4, 1933, 806, Dermacentrozenus richettsı var. brasılıensis Pinkerton, Parasitology, 23, 1936, 186.) Richettsia dermacentroxenus, a corruption of Dermacentroxenus rickettss. though widely used, has no genuine tavonomic standing. Named for Howard Taylor Ricketts, who first transmitted the disease from human cases to mankeys and guinea pigs with the production of characteristic symptoms and lesions and fatal offect.

Minute paired organisms surrounded by a narrow clear zone or halo and often lanceolate, resembling in appearance a minute pair of pneumococci. Appreximately 0 2 to 0 3 micron by 1 micron. Non-motile:

In smears of mammalish tissues there occur in addition to the isaccolate forms. slender rod-shaped forms stained blue with the Giemsa staln, sometimes evhibiting polar granules, stained purplish or reddish. There are also minute pale blue-staining rounded forms. In the tick there are three forms: (1) Pale blue bacillary forms curved and club-shaped. (2) smaller bluish rods with decply staining chromstoid granules and (3) more deeply staining, purplish, Isnecolate forms. A very minute form may appear in tightly packed masses in the nuclei of the cells. Occurs in the cytoplasm and nucleus in all types of tissue in the tick and in the vascular endothehum, in the serosal cells of the peritoneal cavity, in the smooth muscle cells of arteriolar walls and in the macrophages of mammals.

In yolk sac cultures and in the Maitland reedia cultures, bacillary formsoften occur in pairs. In single smears from infected yolk sacs, the rickettsian ner rather uniform in size and morphology and are definitedly larger than Rickettsia procaractsi and Rickettsia typhi. They also grow more sparsely. Stain blue with the Castafeda stain and bright red against a blue background of tissue with the Machiavello stain

Cultivation May be cultivated in plasma tissue culture of mammalian cells, in Maitland media with and without agar, on the chorn-allantoic membrane and in the yolk see of the chick embryo, and in ticks.

Optimura temperature 32°C in plasma tissue culture, 35°C in chick embryo eciis.

Immunology. Prolonged immunity in man and animals after recovery from infection. Killed vaccines produced frem infected ticks and from infected yolk eacs afford considerable protection against the disease. Therapeutic antisers have been produced by the injection of rabbits with tick virus and with infeeted volk sac. No cross immunity between spotted fever in guinea pigs recovered from infections with Rickettsia rickettsu and typhus in guinea pigs recovered from infections with Richettsia prograzekii and Rickelling typhi. Cross immunity between spotted fever in gunea pigs recovered from infections with Rickettsia rickettsii and boutonneuse fever in guinea pigs recovered from infections with Rickettsia conorii, but spotted fever vaccine does not protect against boutonneuse fever of the Mediterranean area or against infections with the South African strains of Riclettsia conorci

Erroneously applied by do Amard and Monteiro to the so-called eastern type of Rocky Mountain spotted fever.—Editors.

Serology Distinguishable from Rickelisa provacchi and Rickettisia-typhi by complement fixation and agglutination with specific antigens. Distinguishable from Rickettsia conorii by complement fixation, though some degree of cross fixation indicates antigenic relationship. Has common antigenic factor with Proteus OX19 but not distinguishable from Rickettsia provagelvi and Rickettsia typhi by Weil-Felx test.

Resistance to chemical and physical agents: Readily inactivated by heat and chemical agents. Destroyed by a temperature of 50°C in 10 minutes, and by 0.5 per cent phenol and 0.1 per cent formalin. Destroyed by desiccation in about 10 hours.

Pathogenicity: Pathogenic for man, monkeys and guines pigs. Rabbits and white rats are moderately susceptible. Animals susceptible in varying degrees include species of ground squirrels, tree squirrels, chipmunks, cotton-tail rabbits, jack rabbits, anowshoe rabbits, marmots, wood rats, weasels, meadow mice and deer mice. In Brazil the opossum, rabbit, dog and cavy have been found naturally infected and the Brazilian plains dog, capybara, coati and certain bats are also susceptible susceptible.

A febrile reaction occurs in guinea pigs with typical scrotal lesions, involving petechial hemorrhages in the skin, which may become necrotic. Virulent strains kill 80 to 90 per cent of the animals, milder strains kill 20 to 25 per cent. Passage in guinea pigs is accomplished by transfer of blood from infected animals. A febrile reaction accompanied by exanthema occurs in mail. Mortality is high in some localities, fow in others.

Source Seen by Ricketts (Jour. Amer. Med Assoc, 58, 1999, 379) in the blood of guinea pigs and monkeys experimentally infected with Rocky Mountain spotted fever and in the salivary glands, alimentary sac and ovaries of infected female Dermacentor ticks and in their ova.

Habitat: Infected wood tick (Derma. center andersoni) and the dog tick (Dermacentor variabilis), also the rabbit tick (Hacmaphysalis leporis-palustris), Ambluomma brasiliensis. Amblyomma cajennense, Amblyomma striatum, Ambluomma americanum and Izodes dentatus. A number of ticks belonging to the genera Amblyomma, Dermacentor, Rhipicephalus. Ornithodoros and Haemahave been experimentally physalis infected. The virus is transmissible through the ova of female ticks. The etiological agent of Rocky Mountain spotted fever. Sao Paulo exanthematic typhus of Brazil, Tobis fever of Colombis and spotted fever of Minas Geraca which are all transmitted to man by the bite of infected ticks

Brumpt. 4. Rickettela conoril (Brumpt, Compt. rend. Soc. Biol., Pans, 110, 1932, 1199; Rickettala megawi var. mineri do Amarai and Monteiro, Mem. Inst. Butantan, 7, 1932, 361; Rickelleid blanes Caminopetros, 1" Cong. Internat. Hyg. Mediterr, Rapports et Compt. rend., 2, 1932, 202; Dermacentrozenus rickettsi var. pipperi Mason and Alexander Onderst, Jour. Vet Sci. and An. Indust , 18, 1939, 74; Dermacentrozenus rickettsi var. conori Mason and Alex ander, ibid; Dermocentroxenus conori Steinhaus, Insect Microbiology, 1946, 339.) Named for A. Conor who with A. Bruch published in 1910 the first clinecal description of boutonneuse fever.

Resembles Rickettsia rickettsii. In the teck, diphecoccoid and diphoberilary forms predominate, though when the nekettsiae occur in compact masses they are smaller and more coccoid. In tessue cultures the organisms are lancelate cultures the organisms are lancelate cultures the organisms are lancelate cultures the organisms are lancelate, occurring in the nuclei as well as in the cytoplasm of the cells. Size 0.3 to 0 to 175 microns. Non-motile.

Stain purplish with the Giemsa stain,

blue with the Castaneda stain and bright red with a blue background with the Machiavello stain. Gram-negative.

Cultivation: May be cultivated in plasma tissue culture of nommalian cells, in modified Maitland media, and in the volk sacs of chick embryos.

Immunology: The disease is related immunologically to Bocky Mountain spotted lever with which it cross immunizes, but the spotted fever vaccine does not protect against the Mediterranean and South African strains of boutonneuse fever.

Serology: Distinguishable from Rickettsia rickettsri by complement firstion Has a common antigenic factor with Proteus OX19 and OX2.

Pathogenicity: Pathogenic for man and gumea pigs. It is also pathogene in varying degrees for degs, horses, spermophiles, monkeys, rabbits, gerbilles and white mice.

Boutonneuse fever is a much less virulent infection for the guinea pig than Rocky Mountain spotted fever. A temperature reaction occurs, accompanied by scrotal swelling but there is no sloughing. There is practically no mortality Passage in guinea pigs is accomplished.

by transfer of blood from an infected animal.

In man, localized primary sores (taches noires) and an inflammatory reaction in the regional lymph nodes occur at the site of the tick bite. A lebrile reaction with evanthema occurs and mortality is law

Source Seen by Cammop@tros (Compt. rend. Soc. Biol., Paris, 110, 1932, 311) in smears from the tunica vaginalis of guinea pigs inoculated with infected dog ticks (Rhipucephalus sanguingus).

Habitat: The bren n dog tiek (Rhipicephalus sanguineus) and also the licks, Irollyarian hebracum, Haemaphyralis leacht, Rhipicephalus appendiculatus and Bašpahus decoloratus. Tranemistible through the ova of adult female ticks. The probable animal receiver is the tolg. The etiological agent of boutonneuse fever in man, also known as eruptive, Mediterranean or Marseilles fever and probably Kenna typins and South African tick bite fever, though the klentity of the latter with boutonneuse fever has been questioned

5 "Rickettsia tsutsugamus hi (Hayashi) Ogata (Theileria teutsugamushi

\*Some may question the use of this binomial on the ground that Haywahi thought that this species was possibly or probably protection in nature when he proposed the name Thetleria trusugamush (loc. cit) in 19.0. However he questions whether Thetleria is the correct generic name in this prigramal accepts the viewpoint that this organism is a rickettain in a paper published in 1921 entitled. On Rickettsia, Trans Jap Path. Soc., 14, 1921, 198-201. He does not use the binomial Rickettian trusugamushi in this paper as inducated by some of his friendam latter papers (Ogata, loc. cit.). Kawamura, loc. cit.) and apparently first uses it himself in a paper entitled, On Testingrumouth Diverse, Jan Path. Soc., 25, 1932, 689.

Hayashi was not the first to recognic the probable retectival nature of the organism of the truiting annellal thesese (see Blake et al., Amer. Jour 11); g. 41, 1915, 207-202, and some even question whether any of the bodies that be bound in human lymphocytes from lymph nodes, in mononuclear endotherlad phases; test of the splica and lymph nodes, and in inciscus taken from the region of the mile but in particular sufficient from tutting similar lever were the same as organisms described as Ried ellina oriental by Nagyo et al. (6x. cut.)

This position is not supported, however, by Nagavo and his associates who admit that their organisms are identical with some of the organisms described by Hyagelit, Mitamura (Trans. Jap 18th Sec. 21, 1911, 400 sums this unsat follows) "Wir stellen

Hayashi, Jour. Parasit., 7, 1920, 63; \*Rickettsia orientalis Nagayo, Tamiya, Mitamura and Sato, Jikken Igaku Zasshi, 14, May 20, 1930, 8 pp.; †Rickettsia isutsugamushi Ogata, Cent. f. Bakt., I Abt., 122, 1931, 249; Rickettsia akamushi Kawamura and Imagawa, ibid , 122, 1931, 258, Rickettsia orientalis var schaffneri do Amaral and Monteiro, Mem Inst. Butantan, 7, 1932, 360; Rickettssa megawi do Amaral and Monteiro, idem; Rickettsia megawi yar. fletcheri do Amaral and Monteiro, abid., 361, Rickettsia tsutsugamushi-orientalis Kawamura, Nisshin Igaku, 23, 1934, 000: Rickettsia neeudotyphi Vervoort, see Donatien and Lestoquard, Acta Conv. Tertii Trop. atque malarise morbia, para I. 1938. 564; Rickettsia sumatranus (sic) Kouwenaar and Wolff, Proc 6th Pacific Sci. Cong. (1939), 5, 1942, 636; Dermacen-

traxenus orientatics Moshkovsky, Uspekhi Souremennoi Biologii (Russian) (Advances in modern biology), 19, 1945, 13) From two Japanese ideographs transiterated tsutsuga, something small and dangerous, and mushi, a creature now known to be armite. If the tending is accepted as forming a Latin genitive the modern meaning of the species name suutsuganushi, would be 'of a dangerous mite'

Small pleomorphic bacterium-like microorganisms, usually thicker than Rickettsia procatekit, Rickettsia typhi, Rickettsia rickettsii and Coxiella burnetii and
ettsia rickettsii and Coxiella burnetii and
less sharply defined. Ellipsoidal or rodshaped, often appearing as a dipleocesu
or as a short bacillus with bipolar staining resembling the plague bacillus. Diffusely distributed in the cytopiasm of
the cell. Size 0.3 to 0.5 bv 0.8 to 2

nicht in Abrede dass Herr Hayasbi bei einem kleinen Teil der von ihn beschriebeaes Körperchen unsere Ricketteia orientalits vor sich gehabt hat". Hayashi vigorossif defends his own observations in the same discussion and the following year after making comparative studies of strains of Rickettsia crientalis and his own Rickettsia tustusyamushi reaches the following conclusion (Icc. cit.) "Rickettsia tustusyamushi and Rickettsia orientalis refer to one and the same species of microorganisms and there seems to be no way in which one can be recognized as differing from the other." Under these conditions the only valid name appears to be Rickettsia testusyamushi.—Editions.

\* These authors publish practically the same preliminary paper is three other places as follows: Compt. rend. Soc. Biol., Paris, 104, June 14, 1930, 637-641; Jap. Jour. Exper. Med., 8, Aug. 20, 1930, 399-318 and Trans. Jap. Path. Soc., £0, 1930, 556-556. The complete report on this work did not appear until the following year: Jap. Jour Exper. Med., 8, March 20, 1931, 87-150—Biltors.

† This binomial apparently first appears in the literature in a review article by Kawamura (Handbuch der path. Mieroorganismen, Kolls and Wassermann, 3 Aufl., 8, 1930, 1939) where it is used incidentally and is attributed to Hayashi, 1922. The fact that Hayashi did not use Rickettia trutugamushi before 1931 is confirmed by Mitamura (Trans Jap. Path. Soc., 21, 1931, 463) who states in a footnote: Kawamura und Ogata geben an, dass Hayashi 1923 fur den Erceger den Namon Rickettia trutugamushi vorgeschlagen hat. Eine solche Angabe Hayashi, is nicht nur uns, sondern auch dem Autor, wie er uns personlich errihlt, unbeksannt." Ogata apparently first used Rickettina trutugamushi in the title of a paper that he presented in 1930 to he 8th Cong. Far East Assoc. Trop Med. which, however, appeared in he Transactions of the Congresse, 2, June, 1932, 167-171 Meanwhile, the same paper with an added discussion of the nomenclature appeared in the Cent. I. Bakt., I Abt., Orig., 121, Oct. 1, 1931, 219-283 and it is this paper that is usually regarded as establishing the use of Rickettias trutungamushi for this species.—Editors.

ce. Nitrites not produced from nitrates.

d. Lipolytic.

98. Pseudomonas polycolor.

dd. Not lipolytic.

99. Pseudomonas viridifiava

993. Pseudomonas viridiflava var. concen-

ddd. Lipolytic action not reported.

100 Pseudomonas ananas.

101. Pseudomonas ligustri,

102 Pseudomonos sesami.
103 Pseudomonos tolaasii.

bbb Acid from sucrose not reported.

e Nitrites produced from nitrates

d. Motile.

101 Pseudomonas zanthochlora.

105. Pseudomonas rhizocionia

cc. Nitrites not produced from mitrates 106 Pseudomonas barkeri

107. Pseudomonas gladioli,

108 Pseudomonas mellea

ccc Nitrate production not reported.

109 Pseudomonas betits.
110 Pseudomonas panacis.

a. Gelatin not liquefied

b. Acid from sucrose

c Nitrites produced from nitrates.

111. Pseudomonas aleurstidis,

ce Nitrites not produced from mitrates

112 Pseudomonas glycinea.

112a Pseudomonas glycinea var japonica.

113 Pseudomonas savastanos.

113a. Pseudomonas savastanoi var frazini.

114 Pseudomonas tonclitana

bb. No acid from sucrose
c Nitrates not produced from nitrates.

115 Pseudomonas calendulae.

116 Pseudomonas cichoris.

117 Pseudomonas cissicola.

118 Pseudomonas nectarophila

119 Pseudomonas viburni

bbb Acid from sucrose not reported

e Nitrites not produced from nitrates.

120. Pseudomonas mori.

121. Pseudomonas stizolobii.

122. Pseudomona: viciae.
2. Green fluorescent pigment not produced or not reported

a Gelatin liquefied.

b. Acid from sucrose.

genus Richettsoides da Rocha-Lima (loc. cit.).

6. Rickettsia akari Huchner, Jellison and Pomerantz. (Pub. Health Rept., 61, 1946, 1682.) From Acarus, a genus of mitee

Minute diplobacilli, occurring intracellularly and extracellularly, and binolarly stained rods. Resemble typical rickettsiae morphologically. Non-motile.

Stain well by Machiavello's method, the organisms appearing bright red against a blue background. Stain poorly with methylene blue. Gram-negative. Occur intracytoplasmically and have been seen intranuclearly in yolk sac cells

Cultivation. In the volk sac of the chick embryo. No growth on artificial culture media.

Immunology. Guinea pigs recovered from rickettsialpox are immune to infection with strains isolated from infected mites.

Serology · Antigens prepared from infected volk sacs are highly specific except for cross reactions with Rocky Mountain spotted fever antigens Sem from convaloscent patients fixed complement with the homologous antigen and usually with Rocky Mountain spotted fever antigens

though at a lower titer. Does not have a common antigenic factor with Proteus strains except that low titers were obtamed in a few recovered cases in agglutination tests with Proteus OX19.

Pathogenicity: Pathogenic for man with focal initial erythematous lesion and adenopathy, followed by fever and appearance of macular rash. No mortalsty. Experimental infections have been produced in white mice and guinea pigs by the ineculation of infected blood (irregularly), and of infected liver and spleen suspensions, infected brain, infeeted lymph nodes, tunica washings of infected animals and by infected yolk saes Symptoms in mice include inactivity, accelerated respiration, ruffled fur, with occasional deaths; in guinea pigs, fever and marked scrotal reactions. Infected embryos are killed in 4 to 7 days. It has not been found nathogenic for monkeys, distinguishing it from . Rickettsia conorus. It is also probably more pathogenic for white mice than Ricketlina conorii.

Source. Blood of a human case of rickettsialnox in New York City.

Habitat: Blood of human cases and an ectoparasite of rodents, the mite (Allodermanussus sanguineus Hirst). The etiological agent of human rickettsialpor.

#### Genus II. Coxtella Philip.

(Subgenus Coziella Philip, Amer. Jour Hyg., 57, 1943, 806, Coziella Philip, Pub Health Repts , U S P. H S , 63, Jan. 9, 1948, 58, not Bengtson, gen. not. as stated in first printing Manual, 6th ed , Jan 26, 1948, 1692)

Small, pleomorphic, rod-shaped and coccoid organisms, occurring intracellularly in the cytoplasm and extracellularly in infected ticks. Stain lightly with aniline dyes Gram-negative They are filterable. Have not been cultivated in cell-free media. Parasites of man and animals which include the etiological agent of Q fever. The type species is Corrella burnette (Derrick) Bengtson

i Coxiella burnetii (Derrick) Bengtson comb nov (Rickettsia burneti Derrick, Med Jour Australia, 1, 1939, 14; Rickettsia diaporica Cox, Pub. Health Rep. 54, 1939, 1826, Rickettsia burneti

var. americana, Anon , Brit. Med. Jour., 2, 1941, 588; Richettsia (Coxiella) burneti Philip, Amer. Jour. Hyg , 37, 1943, 306.) Named for F. M. Burnet who discovered the organism in Australia

microns. Non-motile Colored purplish with the Ciemsa stain, and red against a blue background with the Machiavello stain. Stains well with azur III and methylene blue. Gram-negative

Cultivation: In plasma tissue culture of mammalian cells; on the choric-allantion membrane and in the yolk sae of the chick embryo; in rabbit teetes and in the endothelial cells overlying Descemet's membrane of the rabbit eve

Immunology: Immunity conferred by infection appears less complete than in typhus and Rocky Mountain spotted fover. Strains from several different areas have been found to cross immunitie in guines pigs, but the true relationship of the disease occurring in different localities remains to be determined. Reciprocal cross-immunity between mite strains and human attrains has been demonstrated in rabbits, hamsters and mice.

Scrology Antigens from different strains vary in sensitivity when tested by complement fization with immune sera. There are probably a number of different types on the basis of complement fixation with immune sera. Has a common antigenic factor with Proteus OV.K.

Besistance to chemical and physical accents. Readily inactivated by heat and chemical agents. Destroyed by a temperature of 50°C for 10 minutes, and by 0.1 per cent formalin and 0.5 per cent phenol.

Pathogenicity: Pathogene for man, monkeys, gibbans, guines pug, iamaters, rats, voles, mice, gerbulles, rabbats (by introocular injection) and chuck embryo. There is wade variation in the virulence of different strains for laboratory ammals, infection being established with great difficulty with some, while others may cause a high mortality.

A febrile reaction occurs in guinea pigs. Passage in guinea pigs and mire is accomplished by moculation of infected spleen or blood from an infected animal, passage in rabbits by intraocular inoculation of blood, lymph node or organ emalsions of infected animals. Ascites, enlarged apteen often with a fibrinous deposit are characteristic.

In man an eschar with adenopathy develops at the site of the mite bite. In scrub lyphus the eschar is not present. A febrile reaction with exanthema occurs and mortality is variable.

In rabbits infection of Descemet's membrane follows intraocular injection of infected material.

Source. Seen by Hayashi in smears and sections of the lesion (scelar) at the site of the mite bits and in smears and sections of the adjacent lyimph nodles from cases of the discase; also seen by Nagayo et al. (less cit) in the endothelial cells overlying Desement's membrane in rabbits inoculated intraocularly with infectious material.

Habitat. The mites (Trombicula alamush, Trombicula deltenis syn. T. welch, 2 rombicula fletcheri and probably several others). Infective through the owa of the adult female. Only the larvae feed on rodents or man. Reservoir hosts are probably certain wild rodents, including house and field rats, nice and votes and probably some birds. The etiological sgent of teutsugmushi disease and scrub typhus (for numerous other designations of the disease see Farner and Katsampes, U. S. Naval Med. Bull., 45, 1911, 800.

Norr. Rickettian inpponica Sellarda. (Sestarda, Amer. Jour. Trop. Med., 5, 1923, 515. Rickettsoider inpponica da Rocha-Lina, in Kolle and Wasserman, Handb. d. path. Mikroorganismen, 3 Aufl., è, 1930, 1320.) This problematical opanism was thought by its author to be the essue of tustuegamuchi disease. Because it was cultivatible by the methods used by Sellarda, it is not now regarded as defentical with Rickettia fusture pursuals Ogetha. Rickettia dea supponica is the type species (innostryp.) of the street of the species (innostryp.) of the

# Genus III. Cowdria Bengtson, gen. nov.

Named for E. V. Cowdry who first described the organism in heartwater of three ruminants, sheep, goats and cattle.

Small pleomorphic, spherical or ellipsoidal, occasionally rod-shaped organisms, occurring intracellularly in tieks Gram-negative. Have not heen cultivated in sheep and goats.

The type species is Cowdria ruminantium (Cowdry) Bengtson.

 Cowdria ruminantium (Cowdry) Bengtson, comb. nov. (Rickettsa ruminantium Cowdry, Jour Exp. Med., 42, 1925, 231; Rickettsia (Cowdria) ruminantium Moshkovsky, Uspekhi Sourennennoi Biologii (Russan) (Advances in Modern Biology), 19, 1915, 18.) From M. I. Ruminantia, the cud-chewing mammals

Differ morphologically from typical rickettsiae, showing usually spherical and ellipsoudal forms, occasionally bacillary forms. Irregular pleomorphic forms occur. Grow in the cytoplasm of cells, sometimes in densely packed masses. Size of cocei from 0.2 to 0.5 micron in diameter in the endothelial cells of animals, 0.2 to 0.3 micron in diameter in the schothelial cells of animals, 0.2 to 0.3 micron in diameter in ticks. Bacillary forms 0.2 to 0.3 by 0.4 to 0.5 micron and pairs 0.2 by 0.8 micron in ticks. Non-motile.

Stain blue with the Giemsa atain and can also be stained by methylene blue and other basic aniline dyes. Gramnegative.

Cultivation not reported.

Immunology. Immunity incomplete after recovery from the infection. The organisms are found in the tissues long after recovery. There is some evidence of a variety of strains.

Pathogenicity Pathogenic for goats, sheep and cattle. Transmissible to goats by inoculation of infected blood intrajugularly. The most characteristic lesion is the bydropericardium of infected animals. The only small animal shown to be susceptible is the ferret

Source: Seen in the endothelial cells of renal glomeruli and in the endothelial cells of the cerebral cortex of animals suffering from heartwater and in the tick, Ambluomma hebraeum.

Habitat: The bont tick (Amblyomma hebracum) and also Amblyomma cariegatum. When the tick is infected in the larval state, it can transmit the infection to the nymphal and adult stages, but the disease is not transmissible through the ova of the adult female tick. The etiological agent of heartwater in sheep, soats and cattle in South Africa.

Appendix I: Further studies of the organism of trench fewer are required before the relationship of Richetting quintana to the other more firmly established species of ricketteiae can be determined. Therefore, it is placed in this appendix.

1. Rickettsia quintana Schminke. (Sebminke, Münch. med. Wehnschr., 64, July 17, 1917, 961; Rickettsia volhusia Jungmann and Kuczynski, Zischr. Lin. Med., 65, 1918, 261; Fossilis quintana auggested as a possible subspecies "if necessary" by Megaw, Trop. Dis. Bull., 60, 1913, 283

Probable synonym: Rickettsia pedicult Munk and da Rocha-Lima, Münch. med Wehnschr., 64, 1917, 1423.

Coccoid or ellipsoidal organisms, often accurring in pairs, more plump and staining more deeply with the Glemas stain than Richettsia prowarehii. Da Rocha-Lima gives their size as 0 2 to 0.4 micron by 0 3 to 0 5 micron. In lice appear as short rods, frequently in pairs and often bipolarly stained. Non-mo-

Stain reddish-violet with the Giemss stain. Gram-negative. Occur extra-

Small bacterium-like, pleomorphic organisms varying in size from coccord forms to well marked rods. Occur as cytoplasmic micro-colonies with diffuse or compact distribution of the organisms through the cytoplasm. Also seen extracellularly, where they appear as small lanceolate rods, diplobscilli and occasionally segmented filamentous forms Chains of 3 to 6 elements often seen Quite uniform in size and morphology in infected volk sacs and in mouse spleen with exceedingly minute forms in heavily infected material. Small lanceolate rods. 0 25 by 0 4 to 0.5 micron, bipolar forms 025 hy 1.0 micron, diplobacilli 025 by 1.5 microns. Non-motile

With Giemsa's stain they appear reddish-purple, with Machiavello's stain bright red against a blue background Gram-negative

Cultivation: May be cultivated in plasma lissue cultures, in modified Maitland media and in the yolk sac of chick embryos

Immunology: There is complete cross immunity between Australian and American strains of Q fever in guinea pigs Stimins from other parts of the world also cross immunite.

Scrology American and Australian strains are identical by agglutination and argulutinin absorption Strains from various countries are serologically related as shown by complement fixation Q fever is distinguishable from other ruckettsial diseases by complement fixation tests. No common antigenic factor with any Proteus stmin has been demonstrated

Filterability The infectious agent of Q fever readily passes Berkefeld N filters which are impermeable to ordinary bacteria and W filters which are impermeable to typhus and spotted fever rickettane

Resistance to chemical and physical agents Comparatively resistant to heat, drying and chemical agents. Survives at least 100 days in cell free media with out loss of titer, resistant to 60°C for 1 hour and to 0.5 per cent formalm and 1 per cent phenol when tested in fertile eggs

Pathogeniesty Pathogenie for man, guinea pig and the white mouse. The monkey, dog, white rat sad rabbit are middly susceptible. Certain bush animals in Australia, particularly the kandicoot, are susceptible and these snimals have been found naturally infected. Other rodents and marsupials are mildly susceptible. Calves have been experimentally infected and coss have been found recovered from naturally acquired infections.

A febrile reaction occurs in guinea pigs but mortality is low except with heavily infected yolk sac which causes a high mortality. On subsutaneous or intra-dermal inoculation a marked inflammatory thickening of the skin occurs at the site of inoculation On autopsy like site of inculation On autopsy like spleen is enlarged from 2 to 12 times by weight and is engorged with blood Transfer in guinea pigs and mice is accomplished by transfer of infected liver and spleen. A febrile reaction often accompanied by pneumonitis occurs in man, but mortality is low.

Source First seen in smears from infecinoculated intraperitoneally with infectious material by Burnet and Freeman (Med Jour Australia, 2, 1937 (2), 231).

Habitat The wood tick, (Dermacentor anderson) and the ticks, Dermacentor eccidentalis, Amblyonma americanum, Hacmaphysalis leporis-palustris, Izodes dentativs and Hacmaphysalis humeroas. Several other species of ticks have been shown to transmit experimentally like virus of Q fever. It has been found to survive in the ova of the fernale ticks (Dermacentor andersons and Hacmaphysalis humerow). The bandeout (Isodomacrures) is probably the natural reservoir of the disease in Austimis. The etiological agent of Q (Queenslant) fever in main.

rend. Soc. Biol., Paris, 126, 1937, 382; Ehrlichia canis Moshkovsky, Uspekhi Souremennoi Biologii (Russian) (Advances in Modern Biology), 19, 1945, 18.) Moshkovsky selects this species as the type species of the subgenus Ehrlichia Moshkovsky (loc. cit.). Found in dogs used for experimental purposes in Algeria. Appears to be transmitted naturally by the dog tick (Rhipicephalus sanguineus) All active stages of the tick transmit the organism and it passes intraovarially from the female to the larvae of the next generation. The organisms are generally spherical in shape and can be seen in the circulating mooncytes. The infection causes a serious and often fatal illness in dogs. Small laboratory animals are not susceptible to the disease.

Rickettsia conjunctivae, Rickettsia conjunctivae bovis and Rickettsia conjunctivae galli, see Family III, Chlamydozoceeac.

Richettsia ctenocephali Sikorn. (Arch. Schiffs: u. Tropenbyg., 22, 1918, 442) Found in eat fless (presumably Ctenocephalides felis) on the surface of the organs in the body cavity and in the commic fluid. Two forms were found which might be two species, one resembling Richettsia pedieuti and the other Richettsia medophage. Hertig and Wolfach (Jour Med. Res. 44, 1921, 329) found Richettsia tenocephali to vary in size and shape from minute cocci to rather large, swollen, curved rods, staining reddish with the Gemas stain

Rickelisia culicia Brimpt. (Ann. Parasitol. Hum. et Comp., 16, 1938, 153.). Found in the stomach epithelium of mosquitoes (Culez fatigans) 12 days after they had been fed on a patient carrying Microfilaria bauerofit. Thought to be pathogenic for the mosquito and possibly for man Occurs in the form of small granules and more often as small bipolar rods. Stains with haenalam, crythrosine-orange and toluidine blue. Gramnecative.

Rickettsia dermacentrophila Steinhaus. (Pub. Health Repts., 67, 1942, 1375) Found in all stages of the wood tick (Dermacentor andersoni). In the epithelial cells of the intestinal diverticula and other tissues of the tick, usually extracellularly but sometimes intracellularly, Not seen in the nuclei of cells. Gramnegative and staining red with the Machiavello stain, and bluish-purple with the Giemsa stain. Stains less deeply with ordinary bacterial stains than most bacteria. Resembles Rickettsia rickettsii morphologically but is slightly larger, Not pathogenic for laboratory animals or for some of the natural hosts of Dermacentor andersoni.

Rickettsia hirundinis Cowdry. (Jour. Exp. Med., 37, 1923, 431.) An organism observed by Arkwright, Atkin and Bacot (Parasitology, 15, 1921, 27) in the tissues of Cimez hirundinis which is probably the same organism to which Cowdry referred as Rickettsia hirundinis. Considered by Steinhaus as a nomen nudum.

Rickettsia kairo da Rocha-Lima. (Cairo rickettsia, Arkwright and Bacot, Brit. Jour. Exper. Path., 4, 1923, 70; da Rocha-Lima, in Kolle and Wasserman, Handb. d. path. Mikroorg., 3 Aufl., 8, 1930, 1361.) Resembles Rickettsia rochalimae and Rickettsia promacekii.

Rickettsia lectularia Arkwright, Atkin and Bacot. (Parasitology, 18, 1921, 27.) Found in the gut of the bedbug (Cimet lectularius) as filamentous and rodshaped organisms. It seems probable that all bedbugs harbor the organism and it is also present in the developing .ova. The location is intracellular. Very pleomorphic, ranging from small coccoid forms to thread-like forms. The small coccord and diplococcoid forms stain deep purple with the Giemsa stain, while bacillary, lanceolate and thread forms stain more red than purple with the Giemsa stain. Not infective for small laboratory animals or for man.

Rickettsia linognathi Hindle. (Parasitology, 15, 1921, 152.) Found in the cellularly in the region of the epithelial

Cultivation: Has not been cultivated in tissue culture and cell-free medium, though Richettsia pediculi, considered by some identical with Richettsia guintana, has been cultivated on human and horse blood sart.

Pathogenicity. Pathogenic for man, causing recurrent fever. No strain has been definitely established in laboratory animals.

Immunology · Partial immunity is produced after an attack of the disease. The disease is characterized by relapses which may occur as long as two years after the initial attack.

Distinctive characteristics: The organism resists a temperature of 60°C moist heat for 30 minutes or a dry hat at 80°C for 20 minutes. It reasts desection in sunlight for 4 months it is filterable under certain conditions but not when in plasma or serum it is present in filtrates of infected vaccine sodiments and excrements of infected line.

Source: Seen in lice fed on trench fever patients by Topfer (Münch med Wehnschr., 61, 1916, 1495)

Habitat- The epithelial luning of the gut of the body louse (Pediculus humanus var. corpores) where they occur extracellularly, and Pediculus capitis. The virus is not transmissible through the ova May be the etological agent of trench fever (Wollymian fever, shin bone fever, five-day fever.

Appendix II: Additional named species are included in Chapter V, Riecktisse, in Steinhaus, Insect Microbiology, Ithaca, 1916, 39-428. Some differ mapfielogically and tinctorally from typical rickettisse, some are not associated with an arthropod vector, some lave been incompletely studied and described, some have been cultivated in cell-free media. Pending the completion of further studies involving possible

cultivation in fertile eggs, the determination of biological properties, and adequate comparative immunological and serological studies, no attempt is made to classify these organisms. The descriptions are condensed from those given by Steinhaus:

Ekrichia (Rickettaia) kurloui Moshkovaky. (Compt. rend. Soc. Biol., Paris, 126, 1937, 379; Ekritichia kurloui Moshkovaky, Uapekhi Souremennoi Biologui (Russian) (Advances in Modern Biology), 19, 1915, 12.) Found in the monocytes of guinea pigs. Described by Kurloff in 1889 as inclusions in the mononuclear cells of guinea pigs and other animals. These became known as Kurloff bodies. However, the parasitism of these bodies is questionable.

Rickettsia arium Carpano. (Riv. Pat. Comp., Jan. 7-Eb., 1926, 1.) Minuto bodies in the leucocytes and tissue cells of a buildinch (\*Pyrrhala suropea) brought to Egypt from Germany. Donation and Lestoquard (Arch. Inst Pasteur Algefic, 18, 1937, 142) suggested that this organism might have been that of psittacesis.

Rickettsia boris Donation and Lestoquard. (Donation and Lestoquard, Bull. Soc Path Exet., 29, 1936, 1057; Ehrlichia bous Moshkovsky, Uspekhi Souremennoi Biologii (Russian) (Advances in Modern Biology), 19, 1945, 18.) Concerned in a disease of cattle which is transmitted by an undentified tick of the cenus Hyalomma The organism occurs in circular or round angled polyconal masses which consist of a large number of tightly pressed, minute spherical granulations These masses are situated in the evioplasm of various monacytes. The organism causes a relatreels light febrile disease in cattle, and an inapparent infection in sleep and fever in monkeys

Rickettsia canis Donation and Lestoquard. (Donation and Lestoquard, Bull. Soc Path Exot., £8, 1935, 418; Ehrlichia (Rickettsia) canis Moshkovsky, Compt. rocha-limae. It causes a febrile illness in man in which relapses occurred 3 to 5 times as in trench fever. RicLettsia weigli was agglutinated by convolescent, sora but not by sera from typhus patients. Convolescent sera gave no positive Weil-Felix reaction.

Wolbachia pipientis Hertig. (Rickettsia of Culex pipiens, Hertig and Wolbach, Jour. Med. Res., 44, 1921, 329; Hertig, Parasitology, 28, 1936, 453.) This is the type species of the genus Wolbachia Hertig (loc. cit ). Found in the overies or testes of the mosquito, and present in all stages o the mosquito's development. The outstanding morphological characteristic of the organism is great pleomorphism. Minute coccoids and short rods may be considered typical, but the usual microscopic field consists of various shapes and sizes. Some forms show bipolar staining with the Giemsa stain. The organism is a harmless parasite of the mesquite. Laboratory animals are apparently not susceptible.

The following unnamed rickettsuse isolated from animals or seen in animals are included in Steinhaus' list of rickettsuse (Insect Microbiology Ithaea, 1946, 314).

A rickettsia was isolated by Parker, Kohla, Cox and Davis (Pub Health Rept., 54, 1939, 1482) from a tick (Ambigomma maculatum). It is pathogenie for guinea pigs and the disease is referred to as the maculatum disease. There is complete eross immunity in guinea pigs between this infection and Rocky Mountain spotted fever and boutonneuse fever, but it differs from these diseases in some particulars.

A rickettsia-like organism was isolated from the reduviid bug (Triotoma rubro-fasciata) by Webb (Entanstology, 52, 1910, 355) It was pathogeme for some inbonutory animals and was maintained in guinea pigs for 5 passages The rickettsiae were transmissible to the

next generation through the egg of the reduvild bur.

A spotted fever type of rickettsin was isolated by Anigstein and Bader (Tevas Repts. Biol. Med., I, 1943, 105) from the dog tick (Rhipicephalus sanguineus), taken from normal dogs. It was pathogenic for rabbits and guinea pigs

A rickettsia was isolated by Anigstein and Bader (Texas Repts. Biol. Med., 1, 1913, 298, 389) from ticks (Amblyonna americanum) collected in Texas. They believed it to be the cause of bullis fever

Rickettsiae were observed by Enigh (Berl. u. Munch. Tierärzti. Wehnschr., 1912, 25) in the leucocytes of a bison calf. No arthropod was associated with this rickettsia.

A rickettsia-like agent pathogenie for guinea pigs was reported by Tatlock (Proc. Soc. Exp Biol. and Med., 51, 1944, 95). The animals had been injected with blood from a patient with "pretibial" fover. No arthropod vector was indicated.

Three species of rickettsis.ilke organisms isolated from the wood-tick
(Dermacentor ondersont) are described
by Noguchi (Jour. Exper. Med., 4),
1226, 513-521. These were named Bacultus rickettsiforms, Bacillus psudozerosis and Bacillus equidistans. All
could be cultivated on cell-free meda
and none was pathogenic for laboratory
animals.

Appendix III: Unnamed rickettsislike organisms seen in the tissues of insects

Hertig and Wolbach (Jour. Med. Res., 44, 1924, 329) list sixteen species of arachnids and twenty-three species of meets which are hosts to rickettsiae or rickettsia-like organisms.

Wolbach (Jour. Amer. Med. Assoc., 84, 1925, 723) reports hosts of non-pathor genie rickettsiae which include fourteen species of arachnids (ticks, mites and spiders) and twenty-two species of insects distributed in nine orders, including

alimentary tract of the goat louse (Lanognathus stenopsis). Resembles Rickettsia trichodectae morphologically and occurs only extracellularly in the lumen of the gut

Rickettsıa melophagi Nöller (Arch Schiffs- u Tropenhyg , 21, 1917, 53 ) Found upon and in the cuticular layer covering the epithelium of the midintestine of the sheep tick (Melophagus ovinus). Occurs characteristically in pairs of fairly uniform size, coccord and sometimes rod-shaped. Gram-negative . but stains fairly well with carbol-fuchsm and gentian violet. Stains deen purple with Giemsa's method and bright red with Machiavello's method Has been cultivated on non-living culture media. a glucose-blood-bouillon agar medium The ability of Rickettera melophage to infect sheep has been the subject of contradictory claims. Small Isboratory animals seem not to be suscentible

Richettera orina Lestoquard and Donatien. (Lestoquard and Donatien, Bull Soc. Path. Exot., 29, 1936, 108, Chrlichia ovina Moshkovsky, Usphekhi Souremennoi Biologii (Russian) (Advances in Modern Biology), 19, 1945, 18 ) Found in the blood of diseased sheep from Turkey and Algeria. The organisms occur as minute coccoid granules, grouped in masses and present only in the monocytes and never in endothelial cells They stain uniformly dark red with the Giemsa stain but did not stain with the Castafieda technic. Infected ticks (Rhspicephalus bursa) are thought to be the vectors.

Richettain piece Mohamed (Munstry Agr. F.gppt., Tech. Sci. Serv. Bull. 214, 1939. 6 pp.) In the monocytes and plasma of the blood of a fish (Tetraodon Johako) shoming necrotic ulcers on its head and both sides of the body. The heart, hver and intestines showed be shorn, they and intestines showed be coid forms wrying from 02 to 04 meron in dataneter and frequently occurring metir.

Rickettsia rocha-limae Weigl. (Przglad. Epidemi., 1, 1921, 375 ) Occurs in lice (Pediculus humanus) but is apparently non-pathogenic either to lice or to vertebrates. Larger and more pleomorphic than Rickettsia prowazekis. In smears or sections of the gut of lice. Rickettsia rocha-limae occurs in agglomerated masses, grouped like staphylococci They occur both extracellularly and intracellularly and stain more deeply than Richettsia prouggelii Weigl claims to have cultivated this species on artificial culture media under anaerobic conditions. Not pathogenic for laboratory animals or man

Rickellina sure Donatien and Gayot, (Bull Soc. Path. Irot, 57, 1912, 324) Causes a disease in same, the pathology of which resembles heartwater of ruminants See Genus III, Cowdria, Family Rickellinacers

Rislettisa truchodectae Hindle. (Paractiology, 18, 1921, 132) in the species of bitting lice (Trichodectas pilosus) which may be found on horses. This insect does not suck blood. The organisms occur extracellularly in the alimentary tract of the lous. The average size is 0 3 to 0 5 by 0 5 to 0 9 micron and occasionally longer forms occur.

Rickettsia weigh Mosing (Arch Inst. Pasteur, Tunis, 25, 1936, 373 ) Concerned in an emilenie disease which broke out in 1931 among employees of the Institute of Biology in Luón also were caraged in feeding supposedly ininfected free on their persons. Mosing and others have suggested the possibility that this rickettain may be an extreme mutant of Rickettsia pediculi, Small coccord to rod shaped organisms staining well with the Gierra stain, usually shightly longer than Rickelling propa-In the lower (Pediculus humanua), the rickettsiar occur extracellalarly in the intestinal lumen forming a layer covering the surface of the coitle. lial hang Not rathogeme for the lause ns is Rickettsia proscazekii and Rickettsia

# FAMILY II. BARTONELLACEAE GIESZCZYKIEWICZ.\*

(Bull. Intern. Acad. Polon. Sci, Classe Sei. Matb. Nat., B (I), 1930, 9-30.)\*\*
Small, often pleomorphic, rod-shaped, coccoid, ring-shaped, filamentous and beaded micro-organisms, staining lightly with aniline dyes, but well with Giemsa's stain. Gram-negative. Parasites of the crythrocytes in man and other vertebrates Knowa to be transmitted by arthropod vectors in some cases. The causative organisms of bartonellosis in man, heemobartonellosis, grahamellosis and eperythrozofnosis in the lower animals. Differ from the protozoa that also parasitize crythrozytes in that the entire parasite stains with an differentiation into cytoplasm and nucleus.

### Key to the genera of family Bartonellaceae.

- 1. Parasites of the erythrocytes and of fixed tissue in man,
- Rarasites of the erythrocytes of lower mammals, increased in susceptible animals by spleneotomy. Eradicated by arsenicals.
- Genus II. Haemobartonella, p. 102

  3. Parasites of the crythrocytes of lower mammals. Not increased in susceptible animals by splenectomy. Not cradicated by arsenicals.
- Genus III. Grahamella, p. 1100.

  4. Blood parantes, found on the crythrocytes and in the plasma of lower mammals.

  Appear as rings, coccoids and short rods. Splenectomy activates latent infections.

  Genus IV. Eperuthrocoon. p 1111.

#### Genus I. Bartonella Strong, Tyzzer and Sellards.

(Bartonia Strong, Tyzzer, Brues, Sellards and Gastiaburd, Jour. Amer Med Assoc., 61, 1913, 1715, not Bartonia Mublenberg, in Willdenow, Neue Schrift Ges Nat. Fr., Berlin, 3, 1801, 444; not Bartonia Sims, Bot. Mag., 1804, not Bartonia Crossman, Essais de Paleoconchologie Comparée, 4me Livr., Paris, 1801; Strong, Tyzzer and Sellards, Jour. Amer. Med. Assoc., 64, 1915, 808; emend. Tyzzer and Weinman, Amer. Jour. Hyg., 30 B, 1939, 143) Named for A. L. Barton who described these organisms in 1909.

Parasites of the crythrocytes which also multiply in fixed tissue calls. On the red blood cells in stained films, they appear as rounded or oval forms or as sleader, straight, curved or bent rods occurring either singly or in groups. Characteristically in chains of several segmenting organisms, sometimes swollen at one or both ends and

\* Prepared by Dr. Ida A. Bengtson (retired), National Institute of Health, Bethesda, Maryland and Dr. David Weinman, Parasitologist to the 1937 Harvard Expedition to Peru, Boston, Mass., April, 1947.

\*\* Partial syn. Anaplasmidae has been proposed as a lamily name to unite the four genera Anaplasma, Grahamella, Bortonella and Epergihoroson by Neitz, Alvander and du Toit (Onderst Jour. Vet. Sci. and An. Ind., 5, 1931, 293). Since the name is derived from Anaplasma, the nature of which is not fully understood and since these authors consider the 4 genera as belonging to the protozean order Haemsperidia, it seems advisable not to consider this nomenclature for the present. The genus Anaplasma (parasites of the red blood cells of cattle) created by Theiler (Transvad Govt. Vet. Bact. Ropt. 1903-9, 7-64, 1910) consists of two species Anaplasma and ginale and Anaplasma centrals. Recent workers are inclined to consider them to be bacterial in nature as they do not show a differentiation into cytoplasm and nucleus.

numerous non-blood-sucking inserts as well as lice and ticks.

Cowdry (Arch Path and Lab Med, 2, 1926, 59) lists seven species of arachids and twenty-four species of macets which are hosts to non-pathogenic rick-ettsiae.

Buchner, P. (Trer und Pflanze in Symbiose. Gebrüder Borntraeger, Berlin, 1930, 900 pp.) Through the text, and particularly on pages 300-664, the rickettisia-like and bacterium-like nucroorganisms occurring intracellularly in

insects and other small animals are discussed, principally from the viewpoint of the biologist

Pailot, A (L'infection chez les Insects, Paris, 1933, 525 pp.) Concerned principally with bacterial infections of insects, but also includes information in intracellular symbiotes and rickettsa-like and bacterium-like microorganisms. Steinhaus, Edward A. (Insect microbiology Ithea, 1916, 188-225) Intra-cellular bacterium-like and rickettsia-like symbiotes are discussed are discussed.

c. Nitrites produced from nitrates.

d. Beef-peptono agar turns dark brown.

123. Pseudomonas alliicola.

124. Pseudomonas gardeniae.

dd. Beef-neptone agar remains uncolored or light discoloration after several weeks.

c. Colonies tan to brown.

125. Pseudomonas caryophylli.

126. Pseudomonas solanacearum.

126a. Pseudomonas solanaecarum var. asiatica.

ee. Colonies white or colorless.

127. Pseudomonas castaneae.

123. Pseudomonas seminum.

cc. Nitrites not produced from nitrates. 129. Pseudomonas passifloriae.

bb. No neid from sucrose.

130. Pseudomonas fabae.

bbb, Acid from sucrose not reported.

c. Nitrites not produced from nitrates.

131. Pseudomonas astragali.

132. Pseudomonas colurnac. 133. Pseudomonas maublancii.

134. Pseudomonas polygoni.

ce Nitrato production not reported.

135. Pseudomonas iridieola. 136. Pseudomonas levistici.

137. Pseudomonas radiciperda.

aa. Gelatin not liquefied.

b. Acid from sucrose.

c. Nitrites not produced from nitrates.

138. Pseudomonas melaphthora.

cc. Gas from nitrates.

139. Pseudomonas helianthi.

bb. No seid from sucrose. c. Nitrites produced from nitrates.

140. Pseudomonas alboprecipitans.

141. Pseudomonas vetasitis.

142. Pseudomonas lianicola.

ec. Nitrites not produced from nitrates.

143. Pseudomonas andropogoni.

144. Pseudomonas woodsii. bbb. Acid from sucrose not reported.

e. Nitrites produced from nitrates.

145. Pseudomonas panici-miliaces.

146. Pseudomonas saliciperda.

ce. Nitrites not produced from nitrates.

147. Pseudomonas eriobotryae.

ana. Gelatin liquefaction not reported.

b Nitrites not produced from nitrates.

148. Pseudomonas wieringae.

frequently headed (Strong et al., loc. cit., 1913), without a distinct differentiation of nucleus and cytoplasm. In the tissues they are situated within the cytoplasm of endothelial cells as isolated elements and grouped in rounded masses. These parasites occur spontaneously in man and in arthopod vectors, are endowed with independent motility, reproduce by binary fission, and may be cultivated by unlimited serial transfers on cell-free media. One species has been recognized. It is known to be established only on the South American continent and perhaps in Central America. Human bartonellosis may be manifested clinically by one of the two syndromes constituting Carrion's disease (Oroya fever or vertuge perunas) or as an asymptomatic infection (definition by Strong, Tyzera and Sellards emend. Tyzer and Weinman (in Weinman, Trans. Amer. Philosoph. Soc., N.S., 55, pt. 3, 1944, 216).

The type species is Bartonella bacelluformes (Strong et al.) Strong et al.

 Bartonella bacililformis (Strong, Tyzzer, Brucs, Sellards and Gastiaburú) Strong, Tyzzer and Sellards (Bartonia bacilliformis Strong et al . Jour Amer Med Assoc , 61, 1913, 1715; Bartonella bacilliformis Strong, Tyzzer and Sellards, Jour Amer. Med. Assoc, 64, 1915, 808, emend Tyzzer and Weinman, Amer. Jour Ifyg 30(B), 1939, 143, also see Weinman, Trans Amer, Philosoph Soc. N S .55, pt 3, 1014, 246 Partial or complete synonyma Bartonella cocoide (sic) Ifercelles, Ann de l'ac de Med , Lima, 9, 1926, 231, Bartonella peruriana Escomel, Bull Soc path Evot , 22, 1929, 351, Eperthyrosoon noguehii Lwoff and Vaucel, Compt rend Sec. Biol , Paris, 103, 1930, 975.) From Latin bacillus, rod and forma, shape.

Small, pleomorphic organisms, showing greatest morphological range in the blood of man, appearing as red-violet rods or coccoids aituated on the red cells. when stained with Gierras's stain. Bacilliform bodies are the most typical. measuring 0.25 to 0.5 by I to 3 microns Often curved and may show polar en largement and granules at one or both ends Rounded organisms measure about 0.75 micron in diameter and a ringlike variety is sometimes abundant semi-solid media a mixture of ruds and granules appear. The organisms may occur singly or in large and small, irregular dense collections, measuring up to 25 microns or more in length Punctiform, spindle-shaped and ellipsoial forms of the organism occur, varying in size from 0 2 to 0 5 by 0 3 to 3 microns.

Gram-negative and non-acid-fast. Stain poorly or not at all with the usual aniline dye stains, but satisfactorily with Romanowsky and Giemsa stains

Motile in the blood and in cultures. One to four unipolar flagella.

Cultivation: Growth in semi-said agar with them rabbit serum and rabbit hemoglobin and in semi-solid agar with blood of man, horse or rabbit with or without the addition of fresh tissue and certain carbohydrates, in other culture media containing blood, serum or plasma, Huntoon's hormone agar at 20 per cent, semi-solid gelatu media, blood-glucosecystone agar, choro-allantoic fluid and solks are of chick embryo

Gelatia not liquefied

No acid or gas in glucose, sucrose, galactose, maltose, fructose, xylose, lactose, mannose, manniol, dulcitol, arabinose, raffinose, rhamnose, devtrin, inutin, salicin and amyedalin

No action on lead acctate.

Acrobic, obligate

Optimum temperature 28°C.

Immunology Natural immunity to infection has not been demonstrated in susceptible species. Acquired immunity apparent both during and after the disease. Bartonellas from different sources appear to provoke similar responses. Bartonellas from Oroya fever protect

against infection with organisms obtained from verruga cases.

Serology: Immune sera fix complement and agglutination of suspensions of Bartonella by sera from recovered cases has been reported.

Pathogenicity: Three forms of the diaease occur in man; the anemic (Oroya fever), the eruptive (verruga peruana) and mixed types of both of the other forms Experimental Oroya fever has not been successfully produced in animals, except rarely in an atypical form in monkeys. Experimental verruga peruana has been produced in man, in a number of species of monkeys and occasionally in dogs.

Source: Blood and endothelial cells of lymph glands, spleen and liver of human cases of Oroya fever.

Habitat: Blood and endothelial cells of infected man, probably also in sand flies (Phlebotomus verruearum and Phlebolomus noguchic).

### Genus II. Haemohattonella Tyzzer and Weinman.

(Amer. Jour. Hyg., 50(B), 1939, 141.) From Greek haemos, blood and the generic name Bartonella.

Includes parasites of the red blood cells in which there is no demonstrable multiplication in the tissues and which do not produce cutaneous eruptions. They are typically rod- or coccoid-shaped, showing no differentiation into nucleus and cytoplasm, occurring naturally as parasites of vertebrates, and are transmitted by arthropods. They are distributed over the surface of the crythrocytes, and possibly sometimes within them. They stain well with Romanowsky type stains and poorly with other pailine dyes. Gram-negative. Not cultivated indefinitely in cell-free material. Rarely produce disease in animals without splenectomy, are markedly influenced by arsenotherapy, and are almost all of world-wide distribution. The experimental host range is restricted, infectivity of a rodent species for other rodents heing common, but for primates unknown.

The type species is Haemobartonella muris (Mayer) Typzer and Weinman.

#### Key to the species of genus Haemobartonella.

- I The etiological agent of haemobartonellosis of the white rat.
  - 1. Haemobartonella muris.
- II. The etiological agent of harmobartonellosis of the dog.
  - 2. Haemobartonella canis.
- III. The etiological agent of haemobartonellosis of the vole.
  - 3. Hasmobartonella microtii.
- IV. The etiological agent of haemobartonellosis of the guines pig.
  - 4. Haemobartonella tyzzeri.
- V. The etiological agent of haemobartonellosis of cattle. 5. Haemobartonella bovis.
- VI. The etiological agent of haemobartonellosis of the hulfalo.
- 6. Haemobartonella sturmanii.
- VII. The etiological agent of baemobartonellosis of the deer mouse.
- 7. Haemobartonella peromyscii.
- VIII. The etiological agent of haemobartonellosis of the gray-backed deer mouse. 7a. Haemobartonella peromyscii var. maniculati.
  - IX. The etiological agent of haemobartonellosis of the short-tailed shrew.
    - 8. Haemobartonella blarinae.
  - X. The etiological agent of haemobartonellosis of the gray squirrel. 9. Haemobarionella sciuris.

 Haemobartonella muris (Mayer) Tyzzer and Weinman. (Bartonella muris Mayer, Arch. f. Schiffs .- u. Tropenhyg., 25, 1921, 151; Bartonella muris ratti Regendanz and Kikuth, Compt rend Soc. Biol , Paris, 98, 1928, 1578; Tyzzer and Weinman, Amer. Jour. Hyg, 30(B), 1939, 143.) From Latin mus. muris, mouse.

Slender rods with rounded ends, frequently showing granules or swellings at one or both extremities, and dumbbell, coccoid or diplococcoid forms May occur individually, in pairs, or in short chains of 3 or 4 elements, and, when abundant, in parallel grouping. The rods measure 01 by 07 to 1.3 microns and as much as half the length of a red cell. The coccoids have a diameter of

01 to 02 micron

They have been found on and in the erythrocytes and in the plasma ferred stains are those of the Romanowsky type, With Girmsa's stein various investigators report an intense red coloration, a bluish tinge with distinct pink shading, blue with purple granules. With Wright's stain, the organisms stain bluish, with reddish granules at the ends With Schilling's methyleno blue-cosm stain the organisms stain a bright red color with the erythrocyte staining blue They stain faintly with Manson's stain, pyronin-methyl green and fuchsin. Gram-negative

There is lack of agreement concerning visibility in the fresh state and motility Various authors report Brownian movement, slow and sinuous motion in the red cell or rapid irotion.

Cultivation: Cultivated with difficulty and divergent results have been reported. Growth on various media reported (blood agar, agar with 2 per cent defibrinated rat blood, horse blood agar, N. N. N. Blutrösplatte of Wethmar, hormone agar with blood of rabbit, horse or man, ascitic fluid ngar, chocolate agar, semi-solid rabbit serum ager, semi-solid rabbit blood agar, Noguchi-Wenyon medium, defibrinated rat blood, glucose broth, Tarozzi broth, peptone water) but usually growth was seant or could not be continued by transfer to the same medium or the organism isolated was noninfectious or the possibility of latent infections in the animal was not excluded. Best results are apparently obtained with semi-solid rabbit serum agar and semisolid rabbit blood agar.

No conclusive results have been reported in tissue culture The organism has been cultivated on the chorio-allantore membrane of the chick embryo.

Filterability Non-filterable with Scitz or Berkefeld N filters.

Immunology: No authentic case of true natural immunity in rate has been established. Acquired immunity occurs in (1) the latently-infected rat, (2) the infected rat after splenectomy and recovery from the disease, the period of resistance corresponding to the duration of latency, (3) the non-splencetomized non-carrier rat following infection, (4) animals other than the rat following infection.

Serology. No precipitins, thrombocytobarm, isoagglutinins, or cold hemolysins have been reported in the scrum of anemic rata, Complement deviation and applutination have been reported with sera from rabbits, rats and guinea pigs miccted with cultures. Rabbits immunized with cultures have given positive Well-Felix reactions with Proteus OX19 and OXK and rat sera recovered from haemobartonellosis have given a positive Weil-Felix reaction and positive acclutination in low dilution with Rickett. era prowazeku

Pathogenicity: Infected blood, liver suspension, defibrinated laked blood, washed red cells, plasma and hemoglobunnic urine may produce infection by the subcutaneous, intravenous, intraperitonral or intracatdias routes. Slight. transient or no hatmolartonellosis occurs in adult non-splenectomized haemobartonella-free alhino rats, adult non-splenectomized albino rats of carrier stock, adult splenectomized rate pre-

viously infected, until 15 weeks to 8 months after infection. Typical haemobartonellosis occurs in adult splenectomized haemobartonella-free albino rate and in young non-splenectomized haemobartonella-free albino rats weighing 20 to 30 grams at 3 weeks. Variable results have been obtained by different investigators with wild mice, guinea pigs. rabbits, hamsters, pigeons and monkeys (Macacus rhesus and Macacus sp ). It is known to be infectious for wild rats, albino mice, rabbits and for two Palestinian rodents (Sphallax (Spalax correct designation) typhlops and Meriones tristrami). Negative results have been reported in dogs, kittens, cats, sheep and various birds. Causes a definite and characteristic anemia without cutaneous eruption.

Arsenical therapy: True sterilization of latent or recognized infection with organic arsenical compounds.

Source: Blood of infected albino rats. Habitat: Ectoparasites such as the rat louse (Polyplaz (Haematopinus) spanulosus), the fiea (Kenopylla chepis) and possibly the bedbug (Camez lectularius) Also found in the erythrocytes of susceptible animals. World wide in distribution.

 Haemobartonella canis (Kikuth) Tyzzer and Weinman. (Bartonella canis Kikuth, Kha. Wehnschr., 1923, 1729; Tyzzer and Weinman, Amer. Jour. Hyg., 30(B), 1939, 151.) From Latin canis, dog.

One of the most pleomorphic of the haemobartonellae, occurring as thin rods, straight or slightly curved, dumbbell-shaped organisms, dots, coccoids, or rings. Chains of rods, coccoids or rings cocur. These consist of only one type of these forms or a mixture of types. The chains may be straight, curved, branched or annular. Variable in size Round forms vary from 0 2 or 0.5 micron to the limit of visibility. Single rod are 0.2 by 1 to 5 microns, while the

composite forms vary from 1 to 4 microns. Situation is epi-erythrocytic.

Giemsa's fluid stains the organism red-violet, usually intensely. Methylene blue used as a vital stain colors the organism distinctly. Gram-negative and non-acid-fast.

Considered non-motile by most investigators.

Cultivation · Cultivation has not been demonstrated in semi-solid rabbit serumagar medium nor in media containing serum of splenectomized dogs, N.N.N., Noguchi's medium for leptospira, blood broth, Chatton's medium covered with vaschine for Trichomastiz.

Filterability: Results equivocal.

Immunology: The outstanding phenomena resemble those found in the rat infected with Haemobartonella muris

Pathogenicity: Splenectomy is essential to infection necompanied by asemia in the dog. Negative results in splenetomized haemobartonella-free guiena Pig. rat, rabbit, and monkey (Cercopitheus sebesus). No infection or anemia in unoperated mice, white mts, young mbbits, young dogs and young guines pigs The splenectomized cat has been found to carry the infection by serial passage.

Arsenical therapy: Complete sterilization obtained by neoarsphenamine.

Source: Erythrocytes of infected splenectomized dogs.

Habitat: Found in dog fleas (Ctenocephalus) and crythocytes of infected animals. Distribution wide-spread, the infection occurring spontaneously in Europe, India, North and South Africa, North and South America.

3. Haemobartonella mitrotii Tyzer and Weinman, (Tyzer and Weinman, Amer. Jour. Hyg., 30(B), 1939, 143, also see Weinman, Trans. Amer Philosoph. Soc., N. S., 55, 1914, 312; questionable synonym Bartonella arvicolae Yakimof, Arch. Inst. Past de Tunis, 17, 1923, 339; Haemobartonella arvicolae Weinman, loc.

cit, 290) From the genus of voles,

In infected animal, morphology resembles that of Haemobartonella cants. the organisms occurring as rods, coccoids, filaments, club forms, ring forms and granular masses In addition to these forms there occur in Giemsa-stamed blood films ovoids, diamond- or flameshaped small forms as well as coarse segmented or unsegmented filaments up to 5 microns in length Filaments may contain one or more rings, or may be composed in part or entirely of diamondshaped, coccoid or evoid elements, sometimes in parallel rows Rods often show intense bipolar staining. Coccoid forms. usually scattered, may occur as aggregates or clumps on the red cell, apparently embedded in a faint blue matrix

A nale blue veil-like substance may cover nearly half of one surface of the red cells and show at its border typical red-violet stained rods or filaments in the Gierosa-stained specimens A boxshaped arrongement of elements is characteristic Organisms lie on the surface of the red cells. In cultures organisms are more uniform in reerahology resembling Bartonella bacıllıformıs Individual organisms are fine rods, 03 by 10 to 2 microns, sometimes occurring in chains and often in clumps Small round forms occur, measuring 0.5 micron in diameter. and occasionally round disk-like structures

Cultivation. Growth in Noguchi's semi-sold serum agar 2 weeks after the oculation with citrated or heparanteed blood and incubated at 23°C shows as white rounded masses, measuring up to about 1 mm in the upper 15 mm of the tube. In tissue culture the organism grows in small, rounded compact masses within the cytoplasm of infected cells Indefinite maintenance of the strains isolated on artificial media has not been ressible.

Pathogenicity Splencetomized white mice and splencetomized Interatory reared voles are readily susceptible to infection. No marked anemis or any mortality in heavily infected animals. Splenectomized dogs, white rats and deer mice are not susceptible.

Source and habitat Erythrocytes of the vole (Microtus pennsyltanicus pennsyltanicus) following spiencetomy. The natural mode of transmission has not been determined though ticks or mites are suspected.

4 Haemobartonella tyzzeri (Weinman and Pinkerton) Weinman. (Bartonella tyzzeri Weinman and Pinkerton) Ann Trop Med, 32, 1038, 217; Weinman, Trans Amer Philosoph. Soc., 53, 1944, 314) Named for Prof Tyzzer who studied baemobartonellae

Single or composite rods from about 0.25 micron by 1.4 to 4.0 microns. Occasional granular swellings and enlarged poles. Short rods also occur averaging 0.2 to 0.3 by 0.8 micron and also round forms with diameters of 0.2 to 0.3 micron Distributed progularly in the red cells.

Stain intensely red-violet with Gioman's or May-Grunnald-Gioman's solutions Gram-negative.

Cultivation Initial cultures on Nogucitiva seam-sold serum agas obtained inregularly. When metubated at 28°C, colonies appear as isolated white spheres about 1 mm in diameter in the upper 8 mm border of the medium. The clumps are composed of rods and granules, with larger round structures or disks occurring occasionally. Also cultinated on the Zusser, Wei and Pitzpatrick modification of the Mutland medium. Prolonged maintenance on seam-solid media has not breen obtained.

Pathogenetty Splenetomized Lacmohartonells free guinea pigs may be infected by blood or cultures injected subcutaneously or intraperitoneally. Splenetomized Haembotanoilla runsifree mis are newsceptible when inoculated with infected guinea-jug blood Waeness rhess monkeys are also insusceptible to inoculations of infected blood, tissue and cultures. Infection of the guinea pig is subclinical in its manifestations, probably due to the small number of parasites in the blood. No definite anemia accompanies infection.

Source and habitat: Erythrocytes of the Peruvian guines pig (Cava porcellus). Has also been encountered in Colombia but not in other parts of the world. Observed in latently infected animals only after spleacetomy. The natural mode of transmission is unknown, though the fica may be a possible vector,

5. Haemobartonella bovis (Donatica and Lestoquard) Weinman. (Donatica and Lestoquard, Bull. Soc. Path. Exot., 27, 1934, 652; Bartonella sergenti Adler and Ellenbogen, Jour. Comp. Path. and Thenp. 47, 1934, 221; (?) Bartonella bovis Rodriguez, Rev del Inst. Llorente, 15, 1935, 5; abst in Bull Inst. Past., 34, 1936, 1933; Weinman, Trans. Amer. Philosoph. Soc., N. S., 55, 1944, 308; Haemobartonella sergent: Weinman, loc. ett., 290; From Latin fos. boxis, oc.

Resembles Haemobartonella muris and II. cants. Occurs as rods, occobacilli and cocc, singly, in pairs or short chains or groups of 10 or more elements. The rods measure 1 2 to 2 microns in length and are very slender The coccobacilli occur singly or in pairs measuring 0.3 by 0.6 to 0 8 micron and the dameters of the cocci are about 0.3 micron. The parasite may occupy a central or marginal position on the red cell, the number on a cell varying from 1 to 20. Not more than 20 per cent of the cells are parasitized.

Using the Romanowsky stam, the organisms stain similarly to the chromatin of Ptroplasma spp.

Source and habitat: In the blood of bulls in Algeria and in a non-splenectomized calf in Palestine.

 Haemobartonella sturmanii Grinberg. (Grinberg, Ann. Trop. Med., 35, 1929, 33; Weinman, Trans. Amer. Philosoph. Soc., N. S., 83, 1944, 313.)

Similar to Haemobartonella bovis and II. canis in morphology and staining properties. Occurs as rods, cocco-bacillary and eoceoid forms, varying in length from 0.5 to 1.5 microns. The number of parasites per infected cell varies from 1 to 15 and they occur individually, seattered irregularly in clumps or semetimes in chains stretching across the cell. At the height of the infection more than 00 per cent of the cells are infected.

Pathogenicity: Causes a temperature rise in buffaloes and slight anemia after duret blood inoculation. Splenectomized rabbits, famsters and splenectomized calves inoculated with blood from infected buffaloes remained free of the parasite.

Source and habitat: In the blood of

Haemobartonella peromyschi Tyzzer.
 (Proc. Amer. Philos. Soc., 85, 1942, 377.)
 Named for the genus of dear mice, Peromyscus.

Occurs as delicate filamentous forms (which may be branched) on the red blood cells. These filaments may become bended and give rise to a number of coccoids and rods from which ring forms may develor.

Stains by Giernsa's method, but staining process must be intense in order to demonstrate the organism

Pathogenicity: Infection transmissible to splenectomized white rats, white mice and voles, producing a more or less severe illness with anemia.

Habitat: In the blood of the deer mouse (Peromyscus leucopus noraboracensis)

Ta. Haemobartonella peromyscii var. maniculati Tyzzer. (Proc. Amer. Philos. Soc., 85, 1942, 381.) Named for the species of mouse from which it was isolated.

Occurs as rods and filamentous

branched forms. Coarser filaments appear to rise from rounded granules. Delicate rods are preponderant, and minute coccoids appear occasionally. When transferred to the common deer mouse, coarser forms appear, including filaments and large occeoids, sometimes in channs.

Pathogenicity: Pathogenic for graybacked deer mice and the common deer mouse, but non-infective for splenectomized white mice.

Habitat: Blood of the gray-backed deer mouse (Peromyscus maniculatus gracilis).

8 Haemohartonella hlarinse Tyzzer (Proc. Amer Philos Soc., 85, 1942, 382) Named for the genus of shrews, Blarina

Extremely pleomorphie with delicate rough and coccus-like forms, often occurring in chains which also contain larger elements which have a deeply staned, bead-like granule. In the early stages of infection they may occur as thek bands or filaments stretching over the red cells usually with a head or ranule

The bands take a bluish tint with Goimax's stain, while the more delicate form stains a slaty violet. The head is distinctly reddish. In the fully developed infection, rooks and filaments predominate over rounded forms. The organisms may be scattered on the surface of the red cells or may form a dense cap which is intensely stained. Rudimentary mycelas may be found radiating fiman central portion and reddish stained material with Ill-defined contours may occur at the ends of the mycelial branches.

Pathogenicity Pathogenic for the short-tailed shrew but not for deer mice or white mice Causes anemia in the shrew.

Habitat. In the blood of the shorttailed shrew (Blarins brericauda)

9 Haemobartonella sciurit Tyrrer (Proc. Amer. Philos. Soc., \$5, 1912, 385.) Named for the genus of gray squirrels, Sciurus.

Very pleomorphie. Occurs as minute rods and filaments which are continuous or segmented. The rods and filaments vary in thickness, some are very uneven and some very coarse Beaded chains may develop from the thickned forms.

The head-like elements stain a dull reddish at the persphery with Gliemas's stain while the remainder is very faintly stained in contrast to the intensely staining basophile rods and filaments. Some of the rounded forms have the appearance of large, thick rugs. Beads and riggs may arise from slender deeply staining rods, simulating very closely spores within beeilf, though no germination of filaments from them has been observed.

Pathogenicity Slightly pathogenic for the gray squirrel, non-pathogenic for normal white mice.

Habitat Blood of the gray squirrel (Sciurus carolinensis leucotis).

Appendix: Here are included (1) Haemobarionalia of undetermined specific rank, (2) Haemobarionalia-like structures in non-splencetomized mammals and in cold-blooded animals, (3) Invalid species (see Weinman, Trans Amer Philosoph Soc, N S, 55, 1911, 315).

1 Hameobartonellae of undetermined specific rank Microorganiums are grouped according to host of origin and are considered to be lacemobartonellae from the description of the original author; but the information furnished is not sufficient for further classification. Haemobartonellae similar to Homo-

bartonella muris in wild rate. Mus decumanus, Mus norcepicus, Rallius rattus frugirorus, Mus railius grissierenter, Mus rattus rattus, Mus sylvaticus. In various ratis, technical names not given.

Haemobartonellae similar to Haemobartonella muris in albino inice. Schilling (Khin Wehnschr., 1929, 55) separated the Isemobartonella of the mouse from that of the rat and named it Bartonello muris musculi var. albinoi (Haemobartonella muris musculi var. albinoi Weinman, loc. cit., 290).

Hacmobartonellae similar to Hacmobartonella muris in other mammals: Hacmobartonella glie glie (Kikuth) Weinman (Bartonella glie glie Kikuth, Cent. I. Bakt., I Abt., 123, 1931, 355; Weinman, loc. ctt., 317) in dornice (Glis glis).

Haemobartonella opossum (Regendanz and Kikuth) Weimman (Bartonella opossum Regendanz and Kikuth, Arch. f. Schills- u. Troponhyg., 32, 1923, 587; Weimman, loc. cit., 200) in the marsupial rat (Mctachirus opossum) and in the opossum (Didelphys didelphys).

Haemobartonella spp. in Lophuromys ansorget, in Lophuromys latteeps, in Conomys bacehante editus, in Praeomys jacksoni, in Arricenthus striatus, in decrements (Fromyseus letcopus novaboracensis), in Chinese hamsters (Cricetulus griscus, Cricetulus griscus, Fundus), in Apodemus agrarius and Phodopus praedilectus), and in squirrels (Securus vulgaris) Mixed infections, including haemobartonellae are found in jerbos, the gerbille and various rodents (see Weimman, loc. ct., 317-319).

2 Haemobartonella-like structures in non-splenectomized mammals and coldblooded animals

Various bodies whose proper classification in the genus Haemobortonella has not been established (Weinman, loc cut, 319) In non-splenectomized mammals:

Bartonella melloi Yakımoff and Rastegaiefi, Bull. Soc Path. Exot., 24, 1931, 471 (Haemobartonella melloi Weuman, loc. cit., 290) in the ant eater (Manis pentadactyla).

Bartonella pseudocebi Pessöa and Prado, Rev. bol c hyg., I, 1927, 116 (Haemobartonella pseudocebi Weinman, loc. ctt., 290) in the monkey (Pseudocebus apella).

Bartonella rocha-lima: Farm and Pinto, Compt. rend. Soc. Biol., Paris, 95, 1925, 1500 (Haemobartonella rocka-limai We man, loc. cit., 290) in the bat (Hel derma brevicauda).

Bartonella sp. in the rat (Ratius ruf cens) and Bartonella sp. in the dormot (Myozus glis).

In cold-blooded animals:

Bartonella parlorskii Epstein, I Union, Inst. Exper. Med., Moscow, 19: 398, see Ray and Idnani, Indian Joi Vet. Sci. and Animal Husb. 10, 1910; 2 (Hacmobartonella parlorskii, Weinmi loc. ct., 290) in the lamprey (Petromy: marinus).

Bartenella nicollei Yakimofi, Arc Inst. Pusteur Tunis, 17, 1928, 350 (Ila mobartonella nicollei Weinman, loc cu 299) in the brochet (Esoz lucius).

Battonella ranarum da Cunha sa Munez, Compt. rend. Soc. Biol., Pari 97, 1927, 1991 (Haemobartonella ranarum Weimman, loc. cit., 290) in the Irog (Lep todactylus occillatus). This is probable identical with Battonella batrachous Zavattari, Boll. d. Soc. ital. biol sper. 6, 1931, 121 (Haemobartonella batrache rum Weimman, loc. cit., 290) from the same species.

Bartonella sp in the geeko (Platydoctylus maurilanieus), Bartonella sp. la the lizard (Lacertilla sp.), Bartonella sp. in the lizard (Tropidurus peruianus), Bartonella sp. in the tench (Tinca tinca) and Bartonella sp. in the tench critics (Testudo gracca).

3. Invalid species:

Bartonella caviae Campanacci, Atenco parmense, 1, 1929, 99 (Haemobartonella caviae Weinman, loc cit., 290) from the guinea pig.

Bartonella uhrainica Rybinsky, Rev. Microbiol. epidem. et parasitol., 8, 1929, 296 (Haemobartonella uhrainica Weinman, loc. cit., 290) from the guinea pig

Weinman (loc. cit., 314) states that the parasitism of these structures was not proven and no illustrations are furnished by the authors.

#### Genus III. Grahamella Brumpt.

(Brumpt, Bull. Soc. Path. Evot., 4, 1911, 514, Grahamia Tartakowsky, Trav. IX\*
Cong. Int. Med. Vet., 4, 1910, 212, not. Grahamia Theobald, Colonial Office, Misc.
Pub. No. 237, 1999)
Named for G. S. Graham-Sunth who discovered the parasite
in the blood of voles.

Parasites occurring within the crythrocytes of the lower insimials which morphologically bear a resemblance to Bartonella, but which are less pleomorphic, more plump, and more suggestive of the true bacteria. They stain more deeply than bartonellae with Giemea's stain, stam lightly with amiline dyes and with methylene blue. They are Grann-negative, non-sud-fast and non-motile. Splenectory has no effect on the source of infection except in rats. They are non-pathogenic and not affected by arsenicals. Several species have been cultivated on cell-free media. The ctiological agent of grabamellosis of rodents and some other vertebrates.

The type species is Grahamella talpae Brumpt

 Grahamella talpae Brumpt (Bull Soc Path Evot , 4, 1911, 514) Named for the genus of moles, Talpa

Long or short rods of irregular contour lying within the red blood cells, many with a marked curve, often near one of the extremities. One or both ends of the longer forms enlarged, giving a nedge or club shaped appearance. Some of the meditim-sixed forms definitely dumbbell-shaped, small forms nearly round.

With Giernsa's stain, the protoplasm of the organism stains light blue, with darker areas at the enlarged ends. Dark staining areas of longer forms give the organism a banded appearance Length varies from 0.1 to 1 micron. Parasites occasionally free in the plasma, but usually in groups. Most of the infected corpuseles contain between 6 and 20 parasites (Graham-Smith, Jour Hyg. 5, 1903, 453).

Pathogenicity Pathogenic for moles

Appendix: In addition to Grahamella talpae Brumpt, descriptions of the following species occur in the literature The list may not be complete and the validity of these species may be ques-

Grahamella acodoni Carini (Ann. Parasit, 2, 1921, 253) From Jeodon serrensis. Brazil

Grahamella alactagae Tartakowaky, (Katalague ider Expanaten der Landurthschaftlichen Ausstellung (Russisch), St. Petersburg, 1913) From "Hactaga schiros and Alactaga acontus in Transcaucasia and steppes of Astrakhan (Alactaga inseptiled Alactaga) Quoted from Yakimoff, Arch f. Protistenk., 68, 1929, 303

Grahametla arealis Tartakowsky. (Katalogue der Exponaten der Landwirthschaftlichen Ausstellung (Hussisch) St. Petersburg, 1913 ) From Microtus arealist in Transcaucisma. Quoted from Yakımoff, Arch. I. Protistenk., 66, 1929, 394

Grahamella balfourn Brumpt (Grahamella pp. Ballour, Rept., Wellcome Tropneal Research Laboratory, 2, 1996, 97, Grahamella balfourn Brumpt, Bull. Soc Path I.vot., Paris, 4, 1911, 517) From the desert rat (Jaculus jaculus) in the Sudan

<sup>\*</sup> Tytser (Proc. Amer. Philos Soc., 85, 1912, 375) finds that grahamellae isolated in culture show a close relationship to Streptobacillus monifyrmus (Actinomices muris) and proposes the inclusion of the genus Grahamella in the family Actinomycetacaes. The latter relationship appears to be very doubtful.

Grahamella Ularinae Tyzzer. (Proc. Amer. Philos. Soc., 85, 1942, 370.) From the short-tailed shrew (Hlarina brevicauda) in Massachusetts.

Grahamella borrs Marzinowsky. (Med. Obosrenie, 1917, No. 1-2.) From the ox (Bos taurus) in Russia. Quoted from Yakimoff, Arch. f. Protistenk., 68, 1929, 304.

Grahamella brumptii Ribeyro and del Aquilla. (Ann. Fac. Med., Lima, 1, 1918, 14-20.) From Deemodus rufus in Peru.

Grahamella cants lupus Kamalow. (Cent f. Bakt., I Abt , Orig., 128, 1933, 197) From the wolf, Tiflis.

Grohamella couchi Neitz. (Onderst. Jour Vet Sci. and An Ind., 10, 1935, 29.) From the multimammate mouse (Mastomus coucha) in South Africa.

Grahamella criceti domestice Parznanidze. (Das Material zum Ifamoparasitismus der Tiero bei Uns. Tifis, 1925.) From Cricetus domesticus in Transcaucasia. Quoted from Yakimoff, Arch f. Protistenk, 96, 1929, 30

Grahamella ericetuli Patton and Hindle. (Proc. Roy. Soc., London, B(100), 1928, 387) From Cricetulus griseus in China

Grahamella dschunlowski Tartakowsky. (Grahama sp., Dschunkowsky and Luhs, Trav IX. Cong Internat Med. Vet., 1909, 4, 1910, 242, Grahama dschunlowski Tartakovsky, 1910) From the bat (Vespertitio noctula) in Transcaucasia Ref. to Tartakowsky quoted from Yakimoff, Arch i Protistenk, 66, 1929, 304.

Grahamella dudtschenkoi Yakumoff (Grahamella p. Dudtschenko, Cent. f. Bakt, I Abt, Orig, 74, 1914, 241; Grahamella dudtschenkoi Yakimoff, Arch f Protistenk., 68, 1929, 301) From the hamster (Crnetiulus sp.) in Transbaikal.

Grahamella ehrlichi Yakımoff. (Grahamella ehrlichi Yakimoff, Arch f Protistenk., 66, 1929, 305.) From the perch (Perca fluviatilis) in Russis. Grahamella francai Brumpt. (Gra hamella sp. Franca, Arch. Inst. Bacter Camara, Pestana, 3, 1911, 277; Graha mella francai Brumpt, Frécis de Parasi tologie, 24me éd., 1913, 102.) From the jumping rat (Eliomys quercinus) in Portugal.

Grahamella gallinarum Carpano. (Ann Parasit. hum. et comp., 13, 1935, 238.) From leghorn chickens in Egypt.

Grahamella gerbilli Sassuchin. (Grahamia gerbilli Sassuchin, Arch. f. Protistenk., 74, 1931, 526.) From Gerbillus lamaricinus in southeast Russia.

Grahamella hegneri Sassuchin (Grahamia hegneri Sassuchin, Arch. f. Protistenk., 75, 1931, 152.) From Citellus promacus în Russia.

Grahamella joyeuze: Brumpt. (Grahamella sp., Joyeux, Bull. Soc. Path Exot., Paris, 6, 1913, 614; Grahamella joyeuzi Brumpt, Préess de Parasitologie, 24me éd., 1913, 192.) Prom Golunda fallaz and Mus rattus in Fronch Guinea.

Grahamella merionis Adler. (Trans. Roy. Soc. Trop. Med., 24, 1930, 78) From Meriones tristrami in Palestine.

Grahamella microti Lavier. (Bull. Soc. Path Exot., Paris, 14, 1921, 573.) From Microtus arvalis in France.

Grahamella micrott pennsylvanici Tyszer. (Proc Amer. Philos Soc, 85, 1942, 366) From the common vole (Microtus pennsylvanicus pennsylvanicus) in Massachusetts.

Grahamella muris Carini (Bull. Soc Path. Exot., Paris, 8, 1915, 104) From the house rat (Mus decumanus) in Brazil

Grahamella muris muscul sherce Parzwaoidze. (Das Material zum Hämoparaatismus der Tiere bei uns Thäs, 1925) From Mus musculus in Trauscaucasia Quode from Yakimoff, Arch f, Protastenk, 65, 1929, 303.

Grahamella musculs Benoit-Bazille. (Bull Soc. Path. Exot, Paris, 13, 1920, 493.) From Mus musculus var albinos in France.

Grahamella ninge kohl-yakomoti Yakimoff. (Bull. Soc. Path. Exot., Paris, 10,

 Pseudomonas aeruginosa (Schroeter) Migula. (Bacterium aeruginosum Schroeter, in Cohn, Beitrage z Biologie, 1, Heft 2, 1872, 126; Bacillus pyocyaneus Gessard, Compt rend. Acad. Sci., Paris, 94, 1882, 536; Micrococcus pyocyaneus Zopf, Spaltpilze, 2 Aufl, 1884, 83; Bacıllua aeruginosus Trevisan, Atti Accad. Fis Med Stat., Milano, Ser. 4, 3, 1885, 11; Bacillus fluorescens Crookshank, Man. of Bact., 3rd ed , 1890, 247; not Bacillus fluorescens Bergev et al., Manual, 1st ed , 1923, 287; Pseudomonas puocuanea Migula, in Engler and Pruntl, Die natürl, Pflanzenfam, 1, Ia, 1895, 29, Bacterium pyocyaneum Lehmann and Neumann, Bakt Diag , 1 Aufl , 2, 1896, 267; Migula, Syst. Bakt , 2, 1900, 884) From Latin, full of copper rust, or ver-

digris; green

Rods: 0.5 to 0.6 by 1.5 microns, occurring singly, in pairs and short chains.

Motile, possessing one to three polar
flagella. Monotrichous (Reid, Naghaki,
Farrell and Haley, Penn Agr Evp Sta,

Bull 422, 1942, 6). Gram-negative. Gelatin colonies Yellowish or greenishyellow, fringed, irregular, skein-like,

granular, rapidly liquefying.

Gelatin stab: Rapid liquefaction

The fluid assumes a yellowish-green or bluish-green color.

Agar colonies: Large, spreading, gray-

Agar colonies. Large, spreading, grayish with dark center and translucent edge, irregular. Medium greenish

Agar slant: Ahundant, thin, white, glistening, the medium turning green to dark brown or black, fluorescent.

Broth: Marked turbidity with thock pellicle and heavy sediment. Medium yellowish-green to blue, with fluorescence, later brownish. Produces pyocyanin, fluoreseein and pyroruhrin (Am Jour. Hyg., 5, 1925, 707).

Latmus milk: A soft coagulum is formed, with rapid peptonization and reduction of litmus Reaction alkaline. Potato: Luxuriant, dirty-hrown, the

medium becoming dark green.
Indole usually not formed (Sandiford,
Jour. Path. and Baet., 44, 1937, 567).

Nitrates are reduced to nitrites and nitrogen.

Glucose, fructose, galactose, arabmose, maltose, lactose, sucrose, dextrin, mulm, glycerol, mannitol and dulcitol are not attacked Acid from glucose (Sandiford, loc. cit.).

Blood serum: Liquefied. Yellow liquid, greenish on surface.

Blood hemolyzed.

Cultures have marked odor of trimethylamine.

Aerobic, facultative

Optimum temperature 37°C.

Pathogenic for rabbits, guinea pigs, rats and mice.

Common name: Blue pus organism.

Source: Pus from wounds Regarded as identical with one of the plant pathogens (Pseudomonas polycolor) by Elrod and Braun (Jour. Bact, 44, 1942, 633).

Habitat Cause of various human and animal lesions. Found in polluted water and sewage

2. Pseudomonas jaegerl Migula. (Bacillus protous fluoracens II Jaeger. Ztechr f. Hyg., 12, 1802, 503; Migula, Syst. d. Bakt., 2, 1900, 883; Bacillus proteus-fluoracens Holland, Jour. Bact., 5, 1909, 220; Proteus fluorescens Holland, bid., 221; Pseudomonas protea-fluorescens Holland, thid, 221) Named for II. Jaeger who first described the species. Short, thick rods, with rounded ends, occurring singly and in pairs. Motile with a tuft of polar flagella which may be pushed to one side where cells remain in a chain. Gram-neartive.

Gelatin colonies: Small, transparent, becoming proteus-like. Gelatin stab: Marked surface growth.

Saccate to infundabuliform liquefaction Liquefied portion green fluorescent.

Agar slant: Thick, yellowish-white layer, the medium becoming greenishfluorescent. At times gas is formed

Broth: Turbid, with greenish-gray pel liele und sediment.

Litmus milk: Not coagulated.

 Eperythrozoon coccoides Schilling. (Schilling, Klin. Wehnscht., 1928, 1851; Gyromorpha musculi Dinger, Nederl. sijdschr. geneesk., 72, 1925, 5995.) From Greek, coccus-shaped.

In stained blood films these organisms appear as rings, exceeded and rods, the majority as rings of regular outline with clear centers. They are in the plasma and on the red cells. Measure 0.5 to 1.4 microns in greatest dimension.

Stain pale red or reddish-blue with the Giemsa or the May-Grunwald-Giemsa technics. Gram-negative.

Suggested methods of multiplication by binary fission, budding, development of small coccoidal to annular forms.

of small coccordal to annular for Cultivation: Negative results.

Immunology: Immunological state in animals that of the premunition type. Latent infection in mice which is made manifest by splenectomy.

Pathogenicity: Pathogenic for white mice, rabbits, white rats, wild mice, usually in young animals or in splencetomized adults.

Source: Blood of splenectomized white

Habitat: Blood of infected animals, mouse louse (Polypiax serrata) and probably other arthropods.

Eperythrozoon ovis Nottz, Alexander and Du Tott. (Neitz et al., Address, Biological Society, Pretoria, Mar 15, 1934; from Neitz, Onderst. Jour. Vet. Sci. and An. Ind., 9, 1937, 9.) From Latin ovis, sheep.

Delicate rings approximately 05 to 10 micron in dumeter though oceasion-ally larger. In addition there are triangles with rounded angles, ovoid, comma, rod, dumbbell and tennis racket forms. Found supra-cellularly on the erythrocytes but often free. Colored pale purple to pinkish-purple with Giemsa's stain Suggested mode of multiplication by budding.

Cultivation · Negative results.

Immunology: Immunological state in sheep appears to be that of the premunition type.

Pathogenicity: Sheep, antelopes and probably goats and sphenectomized calves are susceptible. Dogs, rabbits and guines pigs are refractory. The distinctive feature of Eprythrozon ords is its ability to provoke illness in normal animals without resorting to sphenectomy.

Source: Blood of infected South Afri-

can sheep.

Habitat: Blood of infected animals. No ectoparasites found on sheep naturally infected, but an arthropod is suspected.

 Eperythrozon wenyonii Adicr and Elienbogen. (Adicr and Elienbogen, Jour. Comp. Path. and Thenp., 47, 1934 (Sept. 3), 220; see Bartonella uenyoni in appendix.) Named for Dr. C. M. Weayon, a student of these organisms.

Morphologically similar to Eperythroroom coccoides. Coccoid and often esicular, staining pale red with Gemas's stain and varying from 0.2 to 15 micross in diameter. Multiplication seems to be by budding and fission, and by filamentous growths from the ring forms, suggesting resemblance to Hyphomycetts, but to 50 or 60 parasites are found on one cell-These are arranged in irregular chains or in tightly packed groups.

Cultivation not reported.

Immunology. The organism creates a state of premunition and latent infection is made manifest by splenectomy.

Pathogenicity: Cattle are susceptible, but sheep are not infected either before or after splenectomy.

Source Blood of infected cattle. Habitat: Blood of infected cattle, arthropod transmission not proven.

4. Eperythrozoon varians Tyzzer. (Proc Amet Philos. Soc., 85, 1942, 337.) From Latin varians, varying. 1917, 99.) From the hamster (Crecetus phoce) in Transcaucasia.

Grahamella peromyse: Tyzzer (Proc. Amer. Philos. Soc., 85, 1942, 363) From the deer mouse (P. leucopus novaboracensis) in Massachusetts

Grahamella peromyses var. manseulati Tyzzer (Proc. Amer. Philos. Soc., 85, 1942, 365) From the gray-backed deer mouse (Peromyseus maniculatus) in Massachusetts.

Grahamella phyllotidis Tyzzer (Proc. Amer. Philos Soc., 85, 1942, 371) From the Peruvian mouse (Phyllotis darwini linatus).

Grahamella pipistrelli Markow. (Grahamis pipistrelli Markow, Russian Jour. Trop. Med., 1926, No. 5, 52) From the

bat (Pspistrellus nathussi) in Russia.

Grahamella rhesi Leger. (Bull. Soc.

Path Exot., Faris, 15, 1922, 680.) From the monkey (Macacus rhosus) in Annam. Grahamella sanii Cerruti. (Arch. Ital.

Grahamella sanii Cerruti. (Arch. Hal. Sci. Med. Col., 11, 1930, 522) From Testudo graeca in Sardinia

Grahamella talassochelys Cerruti. (Arch Ital Sci. Med. Col., 12, 1931, 321.) From Tallasochelys caretta in Sardinia. (Misspelled for Thalassochelys.)

#### Genus IV. Eperythrozoon Schilling.

(Schilling, Klin. Wchnschr, 1928, 1851, Gyromorpha Dinger, Nederl. tijdschr, geneesk., 72, 1928, 5903 l. From Greek meaning animal on red blood cell

Microscopic blood parasites found in the plasms and on the crythrocytes. They stain well with Romanowsky type dyes, and then appear as rings, exceeds or short rode, I to 2 microns in greatest dimension, staining bluish or pinkish violet. They show no differentiation of nucleus and cytoplasm. The organisms are not known to retain the violet in Gram's method or to be acid-slendoil-fast. Splencetomy activates latent infection Not cultivated in cell-free media. Arthropod transmission has been established for one species (Weinman, Trans. Amer Philosoph. Soc., N.S. 85, pt. 3, 1944, 321)

The type species is Eperythrozoon coccordes Schilling.

#### Key to the species of genus Eperythrozoon.

- I. Etlological agent of eperythrozoonous of white mice
- 1 Eperythrozoon coccoides.

  II. Etiological agent of eperythrozoonosis of sheep.
- 2. Eperythrozoon our.
  III. Etiological agent of eperythrozoonosis of cattle
- 3 Eperythrozoon wenyonis.
- IV. Etiological agent of eperythrozoonosis of gray-lacked deer mice
  - V. Etiological agent of eperythrozoonosis of voles and dwarf mice
    5 Eperuthrozoon dispar.

<sup>\*</sup> This genus has been considered as belonging to the Protocos by Neitz, Alexander and Du Toit (Onderst J. Vet Sci. 5, 1931, 283) and to the bacteria by Mesnil (Bull. Soc. Path. exot., 22, 1929, 531-and by Tyrrer (in Weinman, Trans. Amer. Philosophi. Soc., N.S., 33, pt. 3, 1911, 241). The evidence at hand favors the inclusion of this group among those organisms which are not protocom in nature but which are closely related to leaterin.

#### FAMILY III. CHLAMYDOZOACEAE MOSHKOVSKY.\*

(Uspekhi Souremennoi Biologii (Russian) (Advances in Modern Biology), 19, 1945, 12.)

Small, pleomorphic, often coccoid microorganisms usually with characteristic development cycle. Stain with aniline dyes. Gram-negative. Behave as obligate intracytoplasmic parasites: Have not been cultivated in cell-free media. Criteria adequate for classification lacking for more recently isolated members. The attribution of Genus III, Colesiota, either to Rickettsiaceae or to Chlamydozoaceae is still in doubt.

Key to the genera of family Chlamydozaaceae.

- I. Cells coccoid and with life cycle.
  - A. Non-cultivatable in chicken embryonic tissues.
  - Genus I. Chlamydozoon, p. 1114.

    B. Cultivatable in chicken embryonic tissues.
- II. Cells pleomorphic.

Genus II. Miyagaranella, p. 1115. Genus III. Colesiota, p. 1119.

Genus I. Chlamydozoon Halberstaedler and von Prowazek.

(Arb. a. d. kaiserl. Gesundheitsamte, 26, 1907, 44.) From Greek chlamydos, closk and 200n, animal.

Coccoid spherical cells with developmental cyclo. Gram-negative. Intracytoplasmic habitat. Non-cultivatable in chicken embryonic tissues. Susceptible to sulfonamide and penicillin action.

The type species is Chlamydozoon trachomatis Foley and Parrot.

1. Chlamydozoon trachomatis Foley and Parrot. (Rickelisio trachomae Busacca, Arch. Ophthalm., 52, 1935, 567; Foley and Parrot, Arch. Inst. Past. d'Algéric, 15, 1937, 339; Rickeltsia trachomalis Foley and Parrot, idem.) Named for the disease, trachoma.

the disease, trachoma.

Coccoid bodies: Small microorganisms
200 to 350 millumerons in diameter form
the elementary bodies. Initial bodies
up to 800 millimicrons in diameter and
plaques up to 10 microns also found. All
larger forms encapsulated with substance
derived either from the agent or from
the cytoplasm of the parasitized cells.
Elementary body is the basic unit.
Paired forms or clusters occur. Gramnegative. Stans poorly with aniline

dyes; blue or reddish-blue with the Giemsa stain and red or blue, depending on the metabolic state, with the Macchiavello stain. Matrix of plaques gives a strong reaction for glycogen. Nonmotile.

Gultivation: Has never been culti-

Immunological aspects: Has one or more antigens in common with or closely resembling one or more present in Migawantila spp. Produces, in low concentrations, antibodies which fix complement with antigen from Miyagananila lamphogramulomatis.

Pathogenicity: Pathogenic for man, apes and monkeys where it affects only

Propared by Dr. Geoffrey Rake, The Squibb Institute for Medical Research, New Brunswick, New Jersey, September, 1945.

Occur in rings, coccoids of varying size, some very minute, bacillary forms

Many of the bacillion elements show an unstained lens-like swelling, indicating the formation of a ting within the substance of the rod. At the beight of the indiction most of the organisms are found in the plasma. Whenever an organism comes in contact with a red cell, it stains intensely

Pathogenesis. Pathogenic for the graybacked deer mouse (causing anemia) and for the splenectomized common deer mouse Not pathogenic for splenectomized white mice

Habitat: Blood of the gray-backed deer mouse (Peromyscus maniculatus gracilis).

 Eperythrozoon dispar Bruynoghe and Vassiliadis (Ann. de Parasitol, 7, 1929, 353)

Resembles Eperythrozon coccodes to staining, distribution on the crythrocytes and also in appearance except that circular disks with solid staining centers may greatly outsumber the ring forms. Found on the red blood cells and in the plasma. Size range that of Eperythrozon coccodes, also some larger ring forms.

Cultivation: Not successful.

Immunology. Infection is followed by premunition and latent infection is made manifest by splenectomy. Splenectomized rabbits premunized against E cocoides do not react to inoculation with E. dispar, if the latter is injected first, they do not react to E cocoides.

Infectivity Infective for the European vole (Articolal Microtus) armiis), the American vole (Microtus pennsylvanicus pennsylvanicus), the dwarf mouse (Mus minutus), the rabbit, and Mus acomys Not infective for albino rats or albino mice.

Source: Blood of infected animals.

Appendix: 1) Species incompletely studied, Eperythrozoon spp. and Eperythrozoon-like structures (Weinman, Trans Amer Philosoph. Soc., N. S. 35, pt 3, 1941, 320).

Eperythrozoon noguchii Lwoff and Vaucel. (Bull Soc path. evot. 26, 1933, 397) Probably not a valid species.

Eperythrozoon perckropost Yakimoff, (Arch. f. Protistenk., 75, 1931, 271.) Classification in genus Eperythrozoon questionable.

Bartonella wenyon: Nieschulz. (2tschr. f. Infektionskr., 53, 1933, 178.) Probably identical with Eperythrezoon wenyon: If valid, Haemobartonella wenyoni.

Possible buman infection (Schüffner, Nederl. tijdschr. v. geneesk., 75, 1939,

3773).

2) Animals infected with parasites which are definitely eperythrozoon-like but of uncertain specificity or which are

eperythrozoon-like in some features but which can not be definitely classified generically.

Jerbos sp. Kikuth. (Cent. f. Bakt., 1

Jerbos sp. Kikuth. (Cent. f. Hakt., I Abt., Orig., 125, 1931, 356.) Arricola accalia Zuelzer. (Zuelzer.

Cent f. Bakt, I Abt., Orig, 102, 1927, 419, Kikuth, Ergebn Hyg. Bakt., Immunitatsforseb u Exper. themp., 13, 1932, 559.)

Rattus rattus Schwetz. (Ann. Soc beige de med. trop. 14, 1931, 277 ) Schurus vulgaris Nauck. (Arch f. Schullus u. Trop. 119g., 31, 1937, 322.) Leptodactiglus pentadactiglus Carini. (Compt. rend. Soc. Biol., Paris, 103, 1300, 1312.)  Miyagawanella lymphogranulomatits Brumpt. (Brumpt, Ann. do Parasit., 16, 1938, 153; Ethlichia lymphogranulomaiosis Mauro, (Reference not faund.) Named for the disease, lymphogranuloma.

Coccoid bodies: Small microorganisms 200 to 350 millimicrons in diameter form the elementary bodies. Initial bodies up to 1 micron and plaques up to 10 microns also found. All larger forms encapsulated with a substance derived either from the agent or from the cytoplasm of parasitized cells. Elementary body is the basic unit. Paired forms are clusters necur. Gram-negative. Stain with aniline dyes, purple with the Giemsat stain and red or blue, depending on metaholic state, with the Macchiavello stain. Matrix of the plaque does not give the reaction for glycogen Non-motile.

Filterability. Passes through Chamberland L<sub>1</sub> and L<sub>2</sub>, Berkefeld V and N and sometimes through Soitz EK filters.

Cultivation: In plasma tissue cultures of mammalian cells, in mammalian cells on agar, in the chorio-aliantole membrane or particularly in the yolk see of the chicken embryo but has not heen cultivated in the aliantole see. Optimum temperature 37°C in tissue cultures, 35°C in the chicken embryo.

Immunological aspects. Has one or more antigens in common with or closely resembling one or more present in tho chlamydozoa and other mivagawanellae. Antisera against any of these two genera react with antigens from Miyagawanella lumphogranulomatis or the other miyagawanellae thus far tested. One common antigen has been isolated as a soluble fraction distinct from the bodies of the agent. Distinguished sharply from the other miyagawanellae by antitoxic neutralization of toxic factor ar by neutralization of infections in mice with chicken Evidence exists that these antisera

two serological reactions are with distinct specific antigens. Immunity in man or animals is probably poor in the absence of continuing apparent or inapparent infection.

Toxic factor: Infected yolk sac or yalk injected intravenously or intratraperitoneally is rapidly fatal to mice. Produces characteristic lesions on the skin of normal guines pigs.

Pathogenicity: Pathogenic for man, assess, monkeys, guinea pigs, cotton rats, hamsters, mice, chicken embryos. In apparent infections may occur with the agent hatbored in the organs. Causes local genital lesions, septicemia, lymphadenitis, meningitis, mpthalmitis sad rarely pneumonitis in man.

Tresue tropisms: In laboratory redents this species is infective by the intranasal (pneumonitis), the intracerebral (menincitis) and the intradermal routes.

Chemotherapy: Susceptible to relatively high concentrations of penicillin, to the sulfonamides and to some antimony compounds.

Source: Most commonly the genital secretions of infected individual or the draining lymph nodes. Also occasionally in blood, spinal fluid and ocular secretions.

Habitat: The etiological agent of lymphogranuloma venereum, lymphogranuloma inguinale, climatic bubo, esthiomène and some forms of anorectal inflammation.

 Miyagawanella psithat (Lillie) Moshkovsky. (Rickettsia psithati Lillie, Publ. Health Repta, 45, 1937, 173.
 Microbacterium multiforme psithacesis Levinthal, 1at Cong. internat. de Microhiol., 1, 1930, 523; Moshkovsky, Uspekhi Souremennoi Biologyi, 19, 1945, Iddwances in Modern Biology), 19, 1945, 12; Etritehia psithaci Moshkovsky, 604, 192). From Patitaci, an order of bitds.

<sup>\*</sup> This is the type species of the genus Microbacterium Levinthal which is invalid because of the earlier Microbacterium Orla-Jensen, 1919, see p. 370.

the cornea and conjunctive causing highly destructive lesions.

Chemotherapy: Susceptible to sulfonamides and penicillin.

Source: Found in scrapings of cornea or conjunctiva in cases of trachoma.

Habitat: The etiological agent of trachoma in man.

2. Chlamydozoon oculogenitale Moshkovsky. (Moshkovsky, Uspekhi Souremennoi Biologii, 19, 1945, (2) From Latin oculus, eye and genitalis, genital. Morphology and staining reactions.

As for Chlamudozoon trachomatis.

Cultivation: Has never been cultivated.

Immunological aspects: As for C. trachomatis.

Pathogenicity: Pathogenic for man, baboons and monkeys. Causes an acute conjunctivitis and, in man, an inflammation of the lower genito-urinary tract.

Chemotherapy: Susceptible to sulfanamides and peniculin.

Source Found in conjunctival crudates, and in exudates from infected urethra or cervix. Also present in contaminated pools of water

Habitat. The etiological agent of swimming pool conjunctivitis, neonatal connunctivitis or inclusion conjunctivitis.

#### Genus II Miyagawanella Brumpt

(Ann. da Parasit., 16, 1938, 153.) Named for Prof. Miyagawa, the Japanese bacteriologist, who first (1935) grew the type species in the chick embryo.

Coccoid to spherical cells with a davelopmental cycle. Gram-negativa. Intracytoplasmic habitat. Cultivatable in chicken embryonic tissues. Soma succles are susceptible to sulfonamide or peniculin action.

The type species is Miyagawanella lymphogranulomatis Brumpt

#### Key to the species of genus Miyagawanella.

- I The etiological agent of lymphogranuloma venereum, lymphogranuloma inguinale, climatic bubo, and esthiomène in man
  - 1. Mayagawanella lumphogranulomatis.
- II. The etiological agent of pattacosis or parrot fever. 2. Mayagawanella psittaci.
- III. The ctiological agent of ornithosis (Meyer).
- 3 Mayagawanella ornithosis. IV. The etiological agent of one type of viral pneumonia.
  - 4. Meyagawanella pneumoniae
  - V. The etiological agent of mouse pneumonatis (Gönnert) 5. Mayagawanella bronchapneumoniae.
- VI. The etiological agent of fefine pneumonitis (Baker).
  - 6. Mayagawanella felis
- VIf. The etiological agent of Louisiana pneumonia 7. Miyazawanella louisianae.
- VIII. The etiological agent called the Illinois virus, the cause of one type of viral pneumonia.
  - 8. Miyagawanella illini.

4. Miyagawanella pneumoniae Rake, spec. nov. Named for the disease, pneumonia.

Coccoid bodies: As for Miyagawanella lymphogranulomatis but slightly smaller,

circa 200 millimierons in diameter. Cultivation As for Myagaranella

psillaci.
Immunological aspects: As for Miyagawanella psillaci. Distinct from Miyagawanella ornithosis by the neutraliza-

Pathogenicity Pathogenic for birds, man, cotton rats, hamsters, white rats, kangaroo rats, mice and chicken embryos Causes a fatal pneumonitis in man.

tion test with chicken antisera.

Tissue tropisms As for Miyagawanella ornithosis

Chemotherapy. As for Mayagaranella ornithosis.
Source: Occurs in lungs of infected bu-

mans. Possibly originally of avian origin.

Habitat. The etiological agent of one
type of viral pneumonia. The type strain
is the so-called strain S-F (Eaton, Beck
and Pearson, Journ. Exp Med, 73, 1941,
641)

5 Miyagawanella bronchopneumoniae Moshkovsky (Moshkovsky, Uspekhi Souremennoi Biologii, 19, 1945, 19, Ehrhchia bronchopneumoniae Moshkovsky, idem) Named for the disease, bronchopneumonia

Coccoid bodies As for Miyagawanella uneumoniae.

Cultivation As for Miyagauanella lymphogranulomatis Does not grow in the allantoic cavity of the chick.

Immunological aspects As for Mayagawanella lymphogranulomatis but no soluble antigen has been demonstrated.

Toxic factor Heavily infected yolk saes and yolk injected intravenously are very rapidly fatal to mice.

Pathogenicity. Pathogenic for mice, ers and ferrets Produces a mod-

.ene tropisms. Shows a predilection

for the lungs. In mice, it is also infective by the intravenous route.

Chemotherapy: Susceptible to sulfonamides and to relatively large doses of penicillin.

Source: Found in lungs of certain stocks of the laboratory mouse.

Habitat: The agent of mouse pneumonitis Bronchopneumonie virus (Gönnert, Cent. f. Bakt., I Abt., Orig., 147, 1941, 151).

 Miyagawanella felis Rake, spec. nov. From Latin felis, cat.

Coccoid bodies: As for Miyagawanella lymphogranulomatis.

Cultivation: As for Miyagawanella

Immunological aspects: As for Migagawanella psittaes but nothing knowa about inapparent infections in the natural host, the domestic cat.

natura nost, the domestic cat.

Toxic factor: Infected yolk sac or other membranes and yolk or other fluids, injected intravenously into mice or chicken embryos or intraperitoneally into mice are rapidly fatal.

Pathogenicity. Pathogenic for cats, hamsters, mice and chicken embryos. Causes a fatal pneumonitis with acute commectivitis in cats.

Tissue tropisms: Prediliction for lungs and conjunctivae. In laboratory rodents, this species is infective by the intranasal, intraperitoneal, intracerebral and intravenous routes.

Chemotherapy: As for Miyagawanella ornethosis

Source: Lungs of infected cats.

Habitat. The etiological agent of one form of cat nasal catarrh, influenza or distemper (Baker, Science, 96, 1942, 475) and feline pneumonitis.

7. Miyagawanella louislanae Rake, spec. nov. Named for the State of Louislana.

Coccoid bodies As for Miyagawanella psittaci. Coecoid bodies: As for Miyagawanella lumphogranulomatis.

Filterability: Partly filterable through Berkefeld N, Chamberland L and Q or Seitz EK filters.

Cultivation: As for Miyagawanella lymphogranulomatis but grows readily in

tymphogranulomatis but grows readily in allantoic sae without adaptation Immunological aspects: As for M

Immunological aspects As for W lymphogranulomatis but no soluble fraction yet demonstrated. Toxic factor, infected yolk sac or

yolk injected intravenously or intrapertoneally is rapidly fatal to mice. Pathogenicity Pathogenic for birds

(particularly psithacune and finelspecies), man, monkeys, guinea pags, pocket gophers, hamsters, white rats, kangaroo rats, mice, rabbits and clucken embryos. Imapparent infections may occur with the agent larbored in the orguns. Causea highly fatla pucumontis with septicemia in man. Tissuo tropisms. Causes a septicems.

In man this species shows predilection for the respiratory tract. In Isboratory rodents, it is infective by the intransasi, the intraperitoneal (peritoritis and septicomia), the intracerebral and the intravenous route.

Chemotherapy Susceptible to relatively high concentrations of penieslin Some strains are susceptible to sulfor-smides.

Source: Found in the organs and nasal secretions of infected birds and, from the latter, spreads to the plumage by preening and other methods. Plentiful in droppings or dust from infected eages. Reli tively resistant under such conditions

Habitat: The etiological agent of psit tacosis or parrot fever. Also of some cases of atypical pneumonis.

Miyagawanella ornithosis Rake.
 spec nov. From Greek ornithos, bird.

Coccoid Indies: As for Viyagewanethi lymphogranulumatis.

Cultivation: As for Mayagawanella pritizei,

Immunological aspects: Has one or more anticens in common with, or closely resembling, one or more present in chiamydozoa and other mivagawaneliae as shown by a cross reaction in complement fixation tests Sharply distinguished from other mivagawanellae by toxinantitovin neutralization or by neutralization of infection in mice with chicken antisera The latter test however suggests that the agent of meningopneumomitis (Francis and Magill, Jour Dap Med . 68, 1938, 147) is this species rather than something distinct Immunity in man or animals is probably poor except in the presence of continuing apparent or manuarent infections Cross reactions suggest that Minagan anella ornithosis may be more closely related to Meyagau anella lymphogranulomatis than 18 M pattact

Toxic factor As for Miyagawanella

Pathogenicity Pathogenic for birds (cepecially non-patitacino species), man, ferrett, gimea pigs, hamsters, white rats, kangaroo rats, mice, rabbits and cheken embryos Inapparent infections may occur. Causes a moderately severe pneumonitis with septicemia in man.

Tissue tropisms. Causes a sopticema In birds and man shows a predilection for the lungs. In laboratory rodents, this species is infective by the intranaval, intracerebral, intracerobral, intracerobral and (with relatively large morals of most strains) intrapertoneal routes. Chemotherapy, Susceptible to relatively and the proposed of the properties of t

tively large doses of penicillin Not susceptible to sulfonamides

Source Found in organs and naval secretions of finches, pheasants (including dimentic clinckens), domestic clinckens, domestic clinckens, domesticated doves, fulmar petrels and other birds. Spreads from the secretions to plumage and droppings.

Habitat The chological agent of ornithosis (Meyer) and meningopneumonitis (Francis and Magill). Habitat: Found in scrapings of cornea or conjunctive or in discharges from affected eyes. Etiological agent of infectious or specific ophthalmia in sheep, cattle and goats.

2. Colesiota conjunctivae-gallii (Coles) Rake, comb. nov. (Rickettsia conjunctivae-galli Coles, Onders. Jour. Vet. Sci. and Indust., 14, 1940, 469.) From conjunctiva and Latin gallus, hen.

punctiva and Latin gattus, nen.

Pleomorphic bodies: Similar to Colesiota conjunctivae. Stain purplish-red or blue with the Giemsa stain.

Cultivation: Has never been cultivated.

Immunological aspects: Unknown.

Pathogenicity: Pathogenic for the domestic fowl. Causes an acute conjunctivitis and keratitis. Tissue tropisms: As for Colesiota con-

Source: As for Colesiota conjunctivae Habitat: The etiological agent of one form of ocular roup in fowls.

Appendix: The following are similar to or identical with the above:

Rickettsia conjunctivae-bovis (Coles, South Afr. Vet. Med. Assoc., 7, 1936, 1) cannot be distinguished from Colesiota conjunctivae by any described characteristics.

Rickettsia lestoquardi Donatien and Gayot. (Bull. Soc. Path. Exct., 55, 1932, 225.) Found ia benign conjunctivitis in swine similar to that which occurs in ruminants.

Filterability: Filters through Berkefeld N and Mandler 6, 7 and 9 filters. Cultivation: In the yolk sac of the

chicken embryo.

Immunological aspects: Indistinguishable from other mivagawanellae by complement fixation tests with yolk sae antigens. Partly distinguished from Migagawanella putitation and M. ornithosis by active immunization in mice and cuinca pics.

Pathogeneity: Pathogenie for man, guarden pirs, cotton rats, mice and chicken embryos. Slightly pathogenie for white rats, golden hamsters and deer mice. Macacus rhesus monkeys, rabbits, mushrats and nutrin are unaffected. Causes a highly fatal pneumonutis and septicema in man.

Tissue tropisms: Causes a septieemia. In man this species shows problection for the respiratory tract. In laboratory rodents it is infective by the intranasal, intraperitoneal, intracercbral, intramuscular and subcutaneous routes.

Chemotherapy. As for Miyagawanella ornithosis,

Source: Sputum and organs of infeeted persons. Habitat: The etiological agent of Louisiana pneumonia (Olson and Larson, U. S. Pub. Health Repts., 59, 1944, 1373), so-called Borg strain.

8. Miyagawanella illini Rake, sprc. nov. Named for the State of Illinois.

Coccold bodies. As for Miyagawanella lymphogranulomatis

Filterability Passes through Berkefeld N or W filters.

Cultivation: In the yolk sac of chicken embryo.

Immunological aspects Distinguished from other muyagwanellae by neutralization tests in mice with chicken antisers and partly from Miyagacanella psittaci, M. ornithosis and M. pneumonia by active somunization in mice.

Pathogenicity · Pathogenic for man and white mice. Causes a highly fatal pneumonitis in man.

Tissue tropisms: Infective in mice by the intranasal, intraperitoneal, intracerebral and subcutaneous routes.

Source Lungs of infected persons. Habitat: The etiological agent called the Illinois virus (Zichis and Shaush-

nessy, Science, 102, 1945, 301).

### Genus III. Colesiota Itale, gen. nor.

(Rickettsia Coles, 17th Rept. Direct Vet Serv. and An Ind. Un. South Africa, 1931, 175.) Named for Prof. Coles who first studied these organisms.

Pleomorphic cells which may be coccoid, triangular, rod-shaped or in the form of rings. Gram-negative. Intracytoplasmic habitat

The type species is Colesiola conjunctivae (Coles) Rake

1. Colesiota conjunctivae (Coles) linke, comb. nor. (Richettina conjunctivae Coles, 17th Rept. Direct. Vet. Serv and An Ind Un South Africa, 1931, 175; Chlamy tisson conjunctivae Mochkowsky, Uspekhi Souremennoi Biologii, 19, 1915, 19) From M. L. conjunctiva, the conjunctiva

Pleomorphic bodies; Average diameter 600 to 950 millimierons. May be solid and cocoud, rod shaped, or triangular, or in form of open rings or horse-shoes No chains. Masses frequent. No capsule. Stains with ordinary aniline dyes but less intensely than bacteria. Gramnegative. Non motife.

Cultivation Has never feen culti-

Immunological aspects: Unknown.

Pathogonicity: Pathogenic for sheep, cattle and goats. Causes acute conjunctivitis and keratitis.

Tissue tropisms: Affects only the conjunctiva and cornea.

Potato: Thick, pale yellow becoming dark brown layer, slimy. The medium becomes bluish-gray.

Indole not formed.

Nitrates not produced from nitrates Acrobic, facultative

Optimum temperature 37°G.

Pathogenie for mice. Source: Regarded by Jacger as the cause of Weil's disease (infectious jaun-

cause of Weil's disease (infectious jaundice) as it was found repeatedly in patients suffering from this disease. See Leptospira icterohaemorrhagiae

Habitat · Water.

3. Pseudomonas fluorescens Mgula. (Bacillus fluorescens liquefaciens Flugge, Die Mikroorganismen, 1896, 239, Migula, in Engler and Prantl, Die naturi. Pflanzenfamilien, 1, la, 1895, 29; Bocterium fluorescens Lehmann and Neumann, Bakt Diag., 1 Aufl., 2, 1890, 272) From Latin, fluor, flowing; M L fluoresco, to fluoresce

Rods: 03 to 0.5 by 10 to 1.8 microns, occurring singly and in pairs Motile, possessing a polar flagellum. Gram-

negative.

Gelatin colonies Circular, with greenish center, lobular, liquefying quickly. Gelatin stab. Infundibuliform liquefaction, with whitish to reddish-gray sediment.

Agar slant · Abundant, reddish layer, becoming reddish-gray The medium shows greenish to olive-brown coloration

Broth. Turbid, floceulent, with yellowish green pellicle and grayish sediment. Litmus milk: No coagulation; becoming alkaline.

Potato · Thick, grayish-yellow, spreading, becoming light sepia-brown in color.

Indole is not formed

Nitrates reduced to nitrites and ammonia.

Acid from glucose

Blood serum liquefied. Aerobic

Optimum temperature 20° to 25°G. Not pathogenic.

Source: Water, scwage, feces

Habitat: Soil and water.

 Pseudomonas viscosa (Frankland and Frankland) Migula. (Bacillus viscosus G. and P. Frankland, Zischr. f. Hyg. 6, 1889, 201; Migula, Syst. d. Bakt., 2, 1900, 900.) From M. L. riscidus, sticky, viscid.

Small rods: 0.5 by 1.5 to 2.0 microns, occurring singly. Motile and presumably polar flagellate. Gram-negative. Gelatin colonies: Grayish, granular,

with fimbriate margin. Medium assumes a green fluorescent color around each colony.

Gelatin stab: Infundibuliform liquefaction. Liquefied portion green fluorescent with greenish-white pellicle. Agar slant: Thin, greenish-white, the,

medium becoming greenish.

Broth · Turbid, with greenish pellicle. Litmus milk: Not congulated.

Potato Moist, chocolate-brown, viscid. Indole not formed.

Nitrites not produced from nitrates.

Destroys nitrate with the production of

Acrobic, facultative.

ammonia.

Distinctive characters: Resembles Pseudomonas fluorescens except that growth on agar, gelatin and potsto is viscid.

Optimum temperature 20°C.

Source: Unfiltered water from Kent, England. Common

Habitat: Water.

5 Pseudomonas faltmountensis (Wright) Chester. (Bacillus fairmountensis Wright, Memoirs Nat. Acad. Sci., 7, 1895, 458; Chester, Man. Determ. Bact., 1901, 311; Achromoboter fairmountense Bergey et al, Manual, 1st ed., 1923, 146.) From M. L. of Fairmount Park (Philadelphia.)

Medium-sized rods, occurring singly, in pairs and in chains. Motile, possessing polar flagella. Gram-negative.

Gelatin colonics Circular, white, translucent. Dark centers with a greenisb shimmer, thinner edges and faint radial lines.

Gelatin stab: Grateriform liquefaction.

Appendix to Order Rickettsiales: The following are described species of intracytoplasmic and intranuclear passites of Protocoa whose relationships to similar parasites of arthropods and vertebrotes are not yet clear. All of the protocoan intracellular parasites are of larger size than typical members of Rickettsiales and some have been placed in genera (Cladothriz, Micrococcus) where the typical species do not live intracellularly.

Genus A Carvococcus Dangeard.

(Compt rend. Acad. Sci. Paris, 154, 1902, 1365.)

Genus established for a bacterial parasite of the nucleus of Euglena; organisms rounded.

The type species is Caryococcus hypertrophicus Dangeard.

- 1. Ceryococcus hypertrophicus Dangeard. (Compt rend Acad. Sci., Paris, 154, 1902, 1365.) Parasitic in the nucleus of a fiagellate (Euglena deses).
- Occurs in the nucleus as an agglomeration of close-set, rounded corpussles. The nucleus increases considerably in volune, the chromatin is reduced to this layers against the raceabrane, the interior of the nucleus is divided into irregular compartments by chromatic trabeculse.
  - 2 Caryotoccus cretus Kirby (Univ. Calif Publ. 2001, 49, 1914, 210) Parasitio in the nucleus of a flagellate (Trichonympha corbula) from the intestine of a termite (Procryptotermes sp.), Madsensea.

Spherules 1 to 15 microns or more in diameter, in preparations appearing clear with usually a chromatic, sharply defined, crescentic structure peripherally or interiorly situated, sometimes with two such bodies or several chromatic granules, praristic in nucleus; parasiticed nucleus enlarged only moderately or not at all, chromatin altered but not greatly diaminshed in amount.

3 Caryococcus dilatator Kirby (Univ Calif Publ Zool., 49, 1944, 238) Parasitic in the nucleus of flagellates (Trickonymphackations and otherspecies of Trickonympha) from the intestine of termites (Glyptotermes iridipennis), Australia, and other species

Spherules 0.5 micron or less in diameter, internally differentiated with stamable granule or stainable region peripherally situated; parositic in nucleus and nucleotus, nucleus becomes greatly enlarged and the chromatin mostly or entirely disappears.

 Caryococcus Invadens Kirby. (Univ. Calif Publ Zool., 47, 1014, 238.)
 Parasitic in the nucleus of a flagellate (Trichonympha peplophora) from the intestine of a termite (Neotermes howa), Madagyscar.

Spherules I to 15 merces in dameter, sometimes arranged in pairs, often internally differentiated with stamable central or peripheral granules or stained arres, praisite in the nucleolus or endoseome and nucleus, praisitud nucleolus becoming greatly enlarged and crossed by trabeculae, eventually consumed; nucleus becoming moderately enlarged, but chromatin not disappearing those properties of the properti

5 Caryococcus nucleophagus Kirby, (Univ Cahi Publ Zeol, 49, 1914, 236.) Parasitic in the nucleus of a flagelitot (Trichanyapha carbula) from the intestine of termites (Procryptotermes 19.), Madagarear, and three species of Kalotermes (6, 1.) Iron Mudagarear.

Prepared by Prof. Harold Kirley, Jr., University of California, Berkeley, California, October, 1916.

Spherules with a diameter of about 0.5 micron, sometimes arranged in pairs, sometimes with a thicker, crescentic, stainable area of the periphery on one side; parasitic within the nucleus, ex-

terior or interior to the chromatin mass, which may be diminished in amount, but does not disappear, nor is the parasitized nucleus appreciably enlarged.

## Genus B. Drepanospira Petschenko.

(Arch. f. Protistenk., 22, 1911, 282.)

Cell incurved in two spiral turns that are not abrupt, one of the ends pointed, the other a little rounded, no flagella, movement believed by means of all the body, no cell division, endospores formed, regular spherical colonies formed by individuals at certain stages of development.

The type species is Drepanospira mülleri Petschenko.

1. Drepanospira millieri Petschenko. (Alullerina paramecti Petschenko, Cent. f. Bakt, I Abt., Orig., 65, 1910, 90; Petschenko, Arch f Protistenk, 22, 1911, 252; see also Kirby, in Calkins and Summors, Protozoa in Biological Research, 1941, 1036) Parassitic in the cytoplasm of Paramecium caudalum.

Developing from a group of curved rods in the cytoplasm to a large, ellipsoidal mass almost filling the body. Nuclear portion occupying part of the cell.

The author regards this genus as belonging in the family Spirillaceae between Spirosoma and Microspira.

Genus C. Holospora Haffkine.

(Ann. Inst. Past , 4, 1890, 151.)

Genus established for bacterial parasites of the ciliate, Paramecium aurelia (\*\*
Paramecium caudatum 1).

The type species is Holospora undulata Haffkine.

1. Holospora undulata Haffkine (Ann. Inst. Past, Paris, 4, 1890, 151.) In the micronucleus of the ciliate Paramectum aurelia (= P. caudatum?).

Gradually tapered at ends; 13, 2 and 23 spiral turns; develops from a small, fusiform body which grows and divides transversely, brings about a great enlargement of the micronucleus, which becomes filled with the spirals (see Drepanospira multer Petschenko).

 Holospora elegans Hafkine. (Haff kine, Ann. Inst Past., Paris, 4, 1890, 164, see also Kriby, in Calkins and Summers, Protozoa in Biological Research, New York, 1941, 1035 ) In the micronucleus of the ciliate, Paramecium aurelia (e-P. caudatum?). Vegetative stage fusiform; elongated, elliptical, nucleus-like body in some; divides equatorisily, budding at one entransformation into spore entails enlargement, clear space separating membrane at idea, spore pointed at ends-

3 Holospora obtusa Hafikin (Hafikine, Ann. Inst. Past , Paris, 4, 1890; 153; also see Fivenskija, Arch. f. Protistenk., 65, 1929, 276.) In the macronucleus of the clinate Paramectum avalta (\*\*P. caudalum f).

Spores not spiralled and both ends are numded. Reproduction by fission, also by formation of a bud at one of the extremities of the fusiform cell. Bodies with rounded ends 12 to 30 microus best also spindle-shaped bodies with pointed ends, 0 5 by 3 to 6 microns (Fiveiskaps, loc cit ).

The following species have been placed in genera belonging in the orders Chlamydobacteriales and Eubacteriales respectively

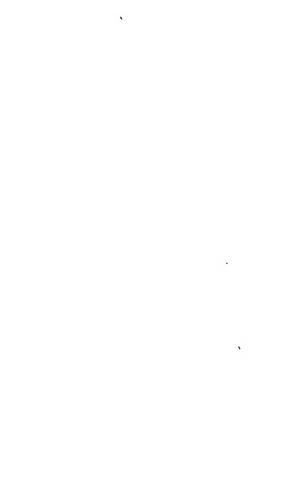
Cladothrix pelamyxae Veley (Veley, Jour Lann See, Zool, 29, 1905, 375; see also Leiner, Veh f. Protustenk, 47 1921, 822, Kirby, in Calkins and Summers, Protoxa in Biological Research, New York, 1911, 1025; Hollande, Bull Itiol. Prance Belg, 79, 1915, 49 ) In the cytoplasm of the rhizopod, Pelamyxa palustris and probabily also other species of Pelamyxa.

Rods, 1.5 to 22 microns or more in length, divided into several to many sections by transverse partitions, generally aggregated in proximity to the nuclei, which may be thickly invested by close-set bacteria applied to the surface

Micrococcus batrochorum (sec) Yakimoff (Arch f. Protistenk., 72, 1830, 137) In the cytoplasm of the flagellate, Trichomonas batrachorum from the tree toad (Hyla arborca). Also seen free in preparations of the intestinal contents of Hyla

Round, I to 15 nucrous in diameter, grouped generally in aggregates of irregular form, but also occur individually

Note. Further descriptions of bacterial and other parameters of Protocoa with bibliography will be found in Calkins and Summers, Protocoa in Biological Research, New York, 1911, 1009-1113 and in hirdry, Univ. of Calif. Pub. in Zanlags, 44, 1916, 193-207.



## SUPPLEMENT NO. 2

# ORDER VIRALES THE FILTERABLE VIRUSES

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#### FILTERABLE VIRUSES\*

The so-called filterable viruses, today generally called merely viruses, are still of unknown affiliations so far as relationships to established groups of microorganisms are concerned. They are treated here as members of an order, consisting of 13 families, 32 genera and 248 species.

Among viruses as we know them, there are three constituent groups that have come to be recognized, and to some extent named and classified, through the largely separate efforts of bacteriologists, animal pathologists, and plant pathologists. Taxonomic overlapping of the three groups, viruses affecting bacteria, viruses having only animal hosts, and viruses invading higher plants, can hardly be justified as yet by available evidence. Nevertheless it has been shown that a single virus may multiply both in a plant host and in an insect vector. This seems to dispose of the thought that adaptation to a plant or animal environment would necessarily predude utilization of other sources of the materials needed for multiplication.

For the present it seems feasible to continue with the custom, tacitly accepted in the past, of classifying bacteriophages separately as one sub-group, viruses causing diseases in need plants as a second sub-group, and those causing diseases in animals as a third sub-group. It should be recognized that this may prove to be only a temporary arrangement, necessary because we have no evidence to warrant taxonomic overlapping of the three groups and useful while we await critical investigations and possible development of a sub-stitute plan capable of displaying natural relationships to better advantage. Eventually evidence may become available to show that some bacteriophages can infect higher plants or animals and can increase in the new environment, or that viruses known to attack animals or plants can similarly enlarge their host ranges. Or, there may be discoveries of common physical properties that would nid in formulating an interlocking classification, for which at present we lack any substantial basis.

It is of especial significance now that the three fields be unified at least by a parallel development of nomenclature. Toward this end the present section of this supplement is directed.

<sup>\*</sup> Supplement No. 2 has been prepared by Francis O. Holmes, The Rockeleller Institute for Medical Research, Princeton, N. J., September, 1914. In this section, suthernites for the names of plant hosts are ingeneral as given by Gray's New Manual of Botany, 7th edition, and Bailey's Manual of Cultivated Plants, 1938, in each of these standard works will be found a first of abbreviations customarily used in botany in citing suthorities for bipomasts.

# ORDER VIRALES Breed, Murray and Hitcheos, (Jour. Bact., 47, 1944, 421.)

Viruses Etiological agents of disease, typically of small size and capable of passing filters that retain bacteria, increasing only in the presence of living cells, giving rise to now strains by mutation, not arising de noto. A considerable number of viruses have not been proved filterable; it is nevertheless customary to include these viruses with those known to be filterable, because of similarities in other attributes and in the diseases ioduced. Some not known to be filterable are iooculable only by special techniques, as by grafting or by use of insect vectors, and suitable methods for testing their filterablity have not been developed; moreover, it is not certain that so simple a criterion as size measured in terms of filterability will prove to be an adequate indicator of the limits of the natural group. Cause diseases of bacteria, plants and anmals.

Key to the suborders of order Virales.

I. Infecting bacteria.

Suborder I. Phagineae, p. 1128.

II. Infectiog higher plants.

Suborder II. Phytophagineae p. 1145.

III. Infecting soimals (insects, mammals).

Suborder III. Zoophagineae, p. 1225.

SUBORDER I. Phaginese subordo novus.

Viruses pathogenic in bacteria, bacteriaphages. Containing at present only one family, the Phagaceae

## FAMILY I. PHAGACEAE HOLMES.

(Handb. Phytopath. Viruses, \* 1939, I.)

Characters those of the suborder. There is a single genus

# Genus I Phagus Holmes

(Loc. cit., 1.)

Characters those of the family. Generic name from Greek phagein, to eat.

The type species is Phagus minimus Holmes

Note: Bacteriophagum d'Herelle (Compt rend. Soc. Biol., Paris, 81, 1918, 1161) a genus name applied in connection with early studies of breteriophages, had as its type species Bacteriophagum intestinate d'Herelle, a bacteriophage that is not now identifiable or, more probably, a mixture of such unidentifiable bacteriophages, for filtrates containing it were said to be capable of killing outright a culture of bacteriophagum, interfore, regarded as a nomen divided, 1160). The genus name Bacteriophagum is, therefore, regarded as a nomen doffurm, if not also a nomen confusum; subsequently it was abandoned by its author, for rensons that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Invensions that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Invensions that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Invensions that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Invensions that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Invensions that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Invensions that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Invensions that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Invensions that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Invensions that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Invensions that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Invensions that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Invensions that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Invensions that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Invensions that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Invensions that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Invensions that are not clear, in favor of the genus name Protobios d'Herelle

<sup>\*</sup> Holmes, F. O., Handbook of Phytopathogene Viruses, Burgess Publishing Company, Minneapolis, Minn., 1933, 221 pp.

d'Herelle (loc cit , 345), presumably the type species of this genus, was not an ordinary virus but was said to be non-parasitic (i.e., free-living) in nature, was capable of reducing sulphur, and is not now identifiable. The genus name Protobos and the corresponding binomial Protobos becterophagus d'Herelle are therefore regarded also as nomina dubia and are not used here. Boctrophagus al Thomberry (Phytopath., 31, 1911, 23) appears to represent a variant spelling of d'Herelle's carlier genus name, it was not accompanied by any indication of what recognitable single bacteriophage served as type and thus does not modify the standing of Bacteriophage.

- Key to the species of genus Phagus.
- I. Dysentery-coli bacteriophages
  - A. Producing large plaques, 8 to 12 mm in diameter
    - 1. Particle size small, 8 to 12 millimserons.
      - 1 Phogus minimus
    - 2. Particle size 15 to 20 millimicrons.
      - 2 Phagus minor.
  - B Producing moderately large plaques, 2 to 6 mm in diameter, with distinct halo,
    - 1 Particle erse 20 to 30 millimicrons
      - 3 Phogus parius.
      - 4 Phagus primorius.
      - 5. Phagus sceundarius.
        6 Phogus duscriteriae.
  - ( Plaques medium size, 1 to 3 mm in diameter, with distinct halo,
    - 1. Particle size 25 to 40 millimicrons.
      - 7 Phagus medsus.
      - 8 Phogus astrictus.
  - D Plaques small, 0 5 to 1 5 mm in diameter, with soft edge or narrow halo
    - 1 Particle size 30 to 45 millimicrons.
      - 9 Phagus major. 10. Phogus cols.
      - 11 Phagus artus.
  - E. Plaques very small, 0 1 to 1.2 mm in diameter, with sharp edges.
    - I. Particle size 50 to 75 millimicrons
      - 12 Phagus maximus
- II Bacteriophages attacking Agrobacterium tumefociens Conn, Pseudomonas solanoccarum Emith, Xonthomonas etta Dowson, Xonthomonas pruni Dowson, Erevina corotorora Holland, Erevina oroideae Holland, Racterium atecepti E F Emith.

- A. Specific for bacterial hosts named above.
  - 13. Phagus tumoris.
    - 14. Phagus solanacearum.
    - 15. Phagus citri.
    - 16. Phagus pruni.
    - 17. Phagus deformans.
    - 18. Phagus contumax.
    - 19. Phagus maidis.
- 111. Bacteriophages attacking Salmonella enteritidis Castellani and Chalmers.
  - 20. Phagus enteritides.
  - 21. Phagus commutabilis.
  - 22. Phagus tertius. 23. Phagus dubius.
- IV. Bacteriophage attacking Salmonella tuphosa,
  - 24. Phague indicens.
- V. Bacteriophages attacking Bacillus megatherium DeBary, Bucillus mycoides Flügge, and Rhizobium leguminosarum Frank.
  - A. Thermal inactivation at 75° C in 10 minutes in vitro.
    - Host may be freed from hacteriophage by heating at 80° C for 10 munutes.
      - 25. Phagus testabilis.
    - 2. Host retains virus even when heated at 90° C for 10 minutes.
      - 26. Phagus indomitus.
  - B. Thermal mactivation at 60° C in 30 minutes.
    - 27. Phagus subvertens.
- VI. Bacteriophages attacking streptococci.
  - 28. Phagus ineplus.
  - 29. Phagus streptococci.
  - 30. Phagus maculans.
  - 31. Phagus lacerans.
  - 32. Phagus tolerans.
  - 33. Phagus michiganensis.
- VII. Bacteriophages attacking staphylococci.
  - 34. Phagus fragilis.
  - 35. Phagus intermedius.
  - 36. Phagus caducus.
  - 37. Phagus alpha.
  - 38. Phagus bela.

Agar slant: Crayisb-white, glistening. Broth: Turbid.

Litmus milk: Alkalıne, litmus reduced Potato: Raised, granular, spreading, viscid

Indole is formed.

Nitrites not produced from nitrates Aerobic, facultative.

Optimum temperature 20° to 25°C.

Habitat: Water.

 Pseudomonas ureae Bergey et al (Culture No 3 of Rubentschick, Cent f. Bakt., II Abt., 72, 1927, 101; Bergey et al., Manual, 3rd ed., 1930, 173.)

Greek, urum, urine; M. L., urca, urea. Rods: 0.6 to 0.7 by 1.7 to 20 microns, occurring singly and in pairs. Motile.

Gram-positive.

Gelatin stab: Infundibuliform lique-

faction.

Agar colonies · Circular, grayish-white.

Agar slant: Grayish-white layer be-

coming greenish-fluorescent.

Broth: Turbid Litmus milk: Peptonized

Potato: Yellowish-brown streak Indole not formed

Nitrates reduced with gas formation Ammonia formed.

Urea attacked.

Hydrogen sulfide formed Methylene blue reduced Aerobic, facultative

Can grow at 0° C. Optimum temperature 20°C.

Optimum temperature 20°C. Habitat: Sewage filter beds

This species is included here through an oversight, It should have been placed in the Appendix to the genus Pseudomonas as the original description is too incomplete to determine its real nature. It is reported to be Grampositive and motile, but the number and arrangement of flagella are not given if it really is Grampositive, the speces as probably periturbons and does not belong in Pseudomonas.

7. Pseudomonas pavonacea Levine and Soppeland. (Bul. No. 77, Iowa

State Agricultural College, 1926, 41.) From Latin, pavo, peacock

Rods: 0.5 by 4.5 microns, with truncate ends, occurring singly and in chains. Motile Gram-negative.

Gelatin stab: Crateriform liquefaction.

Medium becoming brown.

Agar colonies: Circular, raised, becoming green, amorphous, entire.

Agar slant: Greenish, smooth, glistening, viscid, medium becoming slightly braun.

Broth Turbid, with viscid sediment. Medium turned dark brown.

Litmus milk. Slightly alkaline. Latmus reduced. Peptonized after 10 days.

Potato No growtb.

Indole not formed. Nitrites not produced from nitrates.

Starch not hydrolyzed.

Blood serum liquefied in 5 days. No acid or gas from carbohydrate

media. Aerobic, facultative.

Optimum temperature 22°C.

Source: Isolated from activated sludge

8 Pseudomonas effusa Kellerman et al. (Kellerman, Meßeth, Scales and Smith, Cent. f Bakt , 11 Abt., 39, 1913, 515; also Soil Science, I, 1916, 472; Cet-lulomonas effusa Bergey et al , Manual, lat ed., 1923, 162, Bacillus effusus appears first es a synonym in Bergey et al., ibid; later used as name of species 5th ed., 1939, 616) From Latin, effusus, ef-d., 1939, 616) From Latin, effusus, ef-d.

ed, 1939, 616) From Latin, effusus, effuse, spread out Rods: 0.4 by 17 microns. Motile with one to three polar flagella. Gram-

negative.

Gelatin stab. Liquefaction.

Agar slant. Luxuriant, glistening, moist, ereamy growth Greenish fluorescence.

Peptone starch agar slant: Abundant, flat, moist rich creamy growth. Medium shows greenish fluorescence

Broth Turbid.

Litmus milk: Alkaline Congulation and digestion. tralized by sera specific for bacteriophages S13, C13, C36, D5, D20, D13, C18, D3, S8, C21, or C16.

Immunological relationships: Member of Smooth Dysentery Resistance Group. Other properties: Particle size, 30 to

45 millimicrons.

Literature: Burnet, Jour. Path. and Bact., 36, 1933, 307-318.

12. Phagus maximus II. (loc. cit., 147). From Latin maximus, greatest, in reference to particle size.

Common names: Bacteriophage C16, C4, C15, C20, C32, C46, D1, D12, D29, D53, H, J, K, and W, L, L.

Hosts: Escherichia coli Castellani and Chalmers; Shigella dysenteriac Castellani and Chalmers.

Induced disease. Small plaques, 0.1 to 1.2 mm in diameter, with sharp edges.

1.2 min in diameter, with snarp edges. Serological relationships: No cross-neutralization reaction with bacteriophages S13, C13, C36, D5, D20, D12, C18, D3, S5, C21, D6, or staphylococcus bacteriophage Au<sup>2</sup> Agglutinated and inactivated by homologous, though not by other, antisera. For agglutination an original titer of 2 × 10° or higher is required; the reaction is visible to the unaided eye after 2½ hours at 50° C and acceeds even after inactivation by heat (70 to 85° C for 30 minutes), formaldehyde, or a photodynamic dye (proflavine)

Immunological relationships: Member of Resistance Group II

Thermal inactivation: At or below 70° to 85° C for 30 minutes

Other proporties: Particle size estimated by filtration as 50 to 75 millimacrons, by centrifuging as 79 to 90 millimicrons, from photographs as 50 to 60 millimicrons Rapidly innectivated by 26.3 per cent urea solution Little or no inactivation by 1:25,000 methylene blus in 2 mm layer 20 cm from 100 candlepower light for 30 minutes Lysis not inhibited by 1.5 per cent or weaker solutions of sodium cutrate Thermolabile specific soluble substance formed in lysed cultures blocks phage antiphage reaction.

Jaterature: Burnet, Brit. Jour. Exp.
 Path., 14, 1933, 93-100, 100-108, 302-308,
 Jour. Path. and Bact., 55, 1933, 307-308,
 7, 1933, 179-184; Burnet and Lush, ibid.
 40, 1935, 455-469; Burnet and McKie,
 ibid., 55, 1933, 299-306.

13. Phagus tumoris II. (loc. cit., 150). From Latin tumor, a swelling, in reference to association of this bacteriophage with bacterial tumors.

Common name: Agrobacterium tumefaciens bacteriophage.

Host: Agrobacierium iumefaciens Conn, most strains.

Insusceptible species: Some strains of Agrobacterium tumefaciens, Bacterum stewarti E. F. Smith, Erwinna atroseptica Bergey et al., E. carolevora Holland, Pseudomonas tabaci Stapp, Xanthomonas beticola Burkholder, X. campestria Dowson, X. citri Dowson, X. phaseoli Dowson X. pruni Dowson and X. vesicaloria Dowson Dowson.

Geographical distribution: United States, Russia.

Induced disease: Plaques 2 to 6 mm in diameter in 4 to 6 hours, edges of plaques spotted, moth-caten in appearance until 40 hours after seeding; enlargement then stops and the edges of the plaques become smooth, double-ringer. Infection of plants by Agrobacterium tumefacient is progressively inhibited by increasing amounts of bacteriophage in inoculum.

Thermal inactivation: At 95° C in 10 minutes (another report says 70° C, time not recorded).

Other properties: Resists dilution to 1:104; storage at 5° C for over 25 months, prompt, though not gradual, dyring; 1 per cent hydrogen peroxide for 72 hours; 95 per cent ethyl alcohol for 1 hour; 70 per cent ethyl alcohol for 6 hours; 2 per cent phenol for 1 hour; 1:3000 nitric acd for 1 hour; N/64 sodium hydroxide for 1 hour; N/64 sodium hydroxide for 1 hour.

Laterature · Israilsky, Cent. f. Bakt,

- 39. Phagus durabilis.
  - 40. Phagus liber.

#### VIII. Bacteriophages attacking vibrios.

- 41. Phagus cholerae.
- 42. Phagus celer.
  - 43. Phagus effrenus.
- 44. Phagus lentus.

Bacteriophages attacking Corynebacterium diphtheriae Lehmann and Neumann.

45. Phagus diphtheriae.

of Resistance Group I.

- 46. Phagus futilis.
- Phagus minimus Holmes (Handb Phytopath Viruses, 1939, 141.) From Ca Latin minimus, least, in reference to size

Common name . Bacteriophage S13
Rosts · Eacherichia coli Castellani and

Chalmers; Shigella dysenteriae Castellani and Chalmers.

Induced disease On plate cultures that

are uniformly covered with confluent colonies of host organisms, this bacterioplage produces large cleared plaques, 8 to 12 mm in diameter, with wide shelving edges.

Serological relationships. No crossneutralization reactions with bacteriophages Cl3, C36, D5, D20, C18, D3, S8, C21, C16, and D6

Immunological relationships: Member of Resistance Group I

Other properties Particle size 8 to 12 millimizerons. Not affected by 20 3 per cent urea solution Little or no inactivation by 1 25,000 methylene blue in 2 mm layer 20 cm from 100 candle-power light for 30 minutes Lysis completely inhibited by 0.23 per cent solution of sodium estrate.

Laterature. Burnet and McKie, Jour Path and Bact., 58, 1933, 299-306, 307-318, 57, 1933, 179-184; Burnet et al., Austral Jour Exp. Bol and Med Sci., 18, 1937, 227-368.

2 Phagus minor II. (loc. cri., 141) From Latin minor, lesser. Common names: Bacteriophage C13, C8, and D44

Hosts: Escherichia coli Castellani and Chalmers, Shigella dysenteriae Castellani and Chalmers.

Induced disease: Large plaques, 8 to 12 mm in diameter, with wide shelving edges.

edges.
Serological relationships: Cross reactions with bacteriophages C8 and D44 but not with bacteriophages S13, C30, D5,

D20, D13, C18, D3, SS, C21, C16, D6 Immunological relationships: Member

Other properties Particle size, 15 to 20 rullimerous Completely inactivated by 1:25,000 methylene blue in 2 mm layer 20 cm from 100 candle-power light for 30 minutes Specific soluble substance formed in lysed cultures blocks phage-

antiphage reaction.
Literature: Burnet, Jour. Path. and
Bact., 36, 1933, 307-318, Bnt. Jour. Exp.
Path. 44, 1933, 100-108.

3 Phagus parvus II. (loc. cit., 142). From Latin parrus, small.

Common names Bacteriophage C36, S18, C38, M, and C37 of Burnet.

Hosta Escherichia coli Castellani and Chalmera; Shigella dysenteriae Castellani and Chalmera.

Induced disease. Moderately large plaques, 2 to 6 mm in diameter, with distinct halo.

18. Phagus contumax spec. nov. From Latin contumax, refractory, in reference to ability of this bacteriophage to withstand heating sufficient to destroy accompanying host cells.

Common name: Erwinia aroideae bacteriophage.

Host : Erwinia aroideae Holland.

Insusceptible species: Agrobacterium tumefaciens Conn, Bacterium formosanum Okabe, Erwinia carolovora Holland, Pscudomonas andropogoni Stapp, P. solanaccarum Smith, P. tomato Burkholder, Xanthomonas campestris Dowson, X. citri Dowson, X maleaccarum Dowson. X. nakatae Dowson, X. phascoli Dowson, X riemicola Dowson

Geographical distribution: Formosa

(Taiwan)

Induced disease · Very small plaques. 0.1 to 10 mm (mostly less than 05 mm) in dameter.

Thermal inactivation; Resists heating at 60° C for 30 minutes without appreciable loss of titer, but host organism is killed by this treatment.

Other properties. Optimum temperaturo for increase, about 25° C. This baeteriophage may be prepared by heating centrifuged cultures at 60° C for 30 minutes as efficiently as by filtration to remove bacteria.

Literature: Matsumoto, Trans. Nat Hist. Soc Formosa, 20, 1939, 317-338, 50, 1940, 89-98; 31, 1941, 145-151, Matsumoto and Sawada, abid, 28, 1938,

247-256

19. Phagus maidis H. (loc. cit , 152) From New Latin mais, corn (maire), host of Bacterium stewarti.

Common name · Bacterium stewarts bacteriophage; Phytomonas stewarti bacterrophage; Aplanobacter stewarti bacteriophage.

Host: Bacterium stewarti E. F. Smith ( Pseudomonas stewarts E. F. Smith, Phytomonas stewart: Bergey et al. and Aplanobacter stewarti McCuiloch).

distribution: Geographical States

Induced disease: In Bacterium stewarli, variation or loss of yellow color, change of viscosity of growth, reduction or loss of virulence. Infection of corn plants by seed-borne Bacterium stewarti is much reduced by treating seeds with this bacterioplage before they are planted.

Thermal inactivation: Above 65° C in 30 minutes.

Other properties: Infective in diations to 10-7. Soon lost from cultures maintained at pH 3.85 to 400, or on Ivanoff's medium, which contains exidiring compounds.

Literature: Thomas, Phytopath, 25, 1935, 371-372; Science, 88, 1938, 56-57; Phytopath., 30, 1940, 602-611.

20. Phagus enteritidis H. (loc. cit, 153). From name of host.

Common names: Salmonella enteritidis bacterioplunge 1, 12, or 33; Group A bacteriophages.

Hosts: Salmonella enteritidis Castellani and Chalmers, S. gallingrum Bergey et al., Shigella dysenteriae Castellam and Chalmers.

Induced disease. Plaques of medium size, usually with surrounding translucent halo.

Immunological relationships: Member of Resistance Group A; host individuals that have acquired resistance to this bacteriophage are resistant to lines 12 and 33, but susceptible to Salmonella enterstides bactersophages 8, 20, and 11, as well as to other strains of Resistance Groups B, C, and D

Literature: Burnet, Jour. Path. and Bact., \$3, 1929, 15-42

21. Phagus commutabilis H. (loc. vit, 153). From Latin commutabilis, variable, in reference to differences within Resistance Group B, typified by this bacteriophage.

Common names: Salmonella enteritidis bacteriophage 8, 18, 28, 31, 34, 38; Group B bacteriophages.

Hosts : Salmonella enteratidis Castellani

II Abt., 67, 1926, 236-242; 71, 1927, 302-311, 79, 1929, 354-370; Kent, Phytopath., 27, 1937, 871-902; Muncie and Patel, Phytopath., 20, 1930, 289-305.

14 Phegus solanecearum II (loc est.,

Common name: Pseudomonas solanacearum bacteriophage.

Host Pseudomonas solanacearum Smith.

Geographical distribution: Formosa (Taiwan)

Induced disease Medium size plaques on plate cultures of Pseudomonas solanacearum

Scrological relationships: When injected into rabbits, this bacteriophage stimulates the production of a specific precipitating antibody not giving cross reactions with anti-bacterial antibodies. Antipliagic serum inactivated at 90° C

in 10 minutes

Thermal inactivation; At 63° C in 10 numutes (61° C in 30 minutes; 66° C in atout 1 minute)

Other properties: Optimum temperature for increase, 34° C

Literature: Matsumoto and Okabe, Jour Plant Prot., 22, 1935, 15-20, Jour. Soc. Trop. Agr., 7, 1935, 130-139, 9, 1937, 205-213

15 Phagus citri II (loc. cit., 149) I'mm name of host

Common name Nanthomonas citra

Host Vanthomonas citrs Dowson, the

Geographical distribution: Formosa (Taiwan)

Induced disease Lysis This bacterophage has been isolated from soil under diseased trees, and once from infected leaves. It may play a role in the destruction of the citrus cauker organism in the soil.

Other properties: Optimum temperature for increase, 30° C

Literature Matsumoto and Okabe,

Agriculture and Horticulture, 12, 1937, 2055-2059.

Phagus pruni H. (loc. cit., 151).
 From name of host.

Common name: Xanthomonas pruni bacteriophage.

Host: Xanthomonas prunt Dowson.

Geographical distribution: United States (from soil beneath infected peach trees).

Induced disease: Lysis in broth cultures; plaques on agar cultures, but characteristics of plaques not described.

Other properties: Estimated diameter 11 millimicrons in broth Resists dilution to 1:10° or more.

Literature. Anderson, Phytopath., 18, 1923, 144; Thornberry, 1bid., 25, 1935, 933-946.

 Phagus deformass II. (loc. ett., 151). From Latin deformare, to disfigure, in reference to malformation of infected host cells.

Common name Erunna carolospra Incteriophage.

Host · Erwinia carototora Holland.

Insusceptible species Appolaeterium tumefocina Cona, eveept in some early tests with possibly mixed bacterophages; Erizma amplorota Winslow et al., E. medons Holland, Salmontla pullorum Bergery et al., S. galtinarium Bergey et al., Shigalla dysenteriae Castellism and Chalmers, Xanthomonas prumi Dowson.

Chalmers, Xanthomonas pruni Dowson Geographical distribution United States (Michigan).

Induced disease: In Ermina carolorora, cells reduced in motility, agglutinsted, malformed, some elongated, others avollen, bulged at one end, bulged in middle, or enlarged and spherics).

Other properties: Itesists dilution to 1.10°, and storage in sterile medium at room temperature for 51 months.

Literature: Coons and Kotila, Phytopath, 15, 1925, 357-370; Mallmann and Hemstreet, Jour. Agr. Res., 25, 1921, 509-602. 25. Phagus testabilis II. (loc. ett., 185). From Latin testabilis, ablo to bear witness, in reference to evidence that this bacteriophage has given, by virtue of its easy destruction when heated in spores, against the hypothesis of frequent spontaneous origin of bacteriophage from the bacterial host.

Common name: Bacillus megatherium

Host: Bacillus megathersum De Bary. Geographical distribution: United States.

Induced disease: Plaques 0.5 mm or less in diameter, with surrounding translucent zone.

Thermal inactivation: In citro, at 75° C in 10 minutes. Spores from infected cultures, after being heated for 10 minutes at 80° C, regularly give rise to subcultures that do not slow the presence of this bacteriophage spontaneously during subsequent growth but that are susceptible to lysis if the bacteriophage is again introduced.

Literature: Adant, Compt. rend. Soc. Biol., Paris, 59, 1923, 1246; Cowles, Jour. Bact., 20, 1930, 15-23.

26. Phagus Indomitus II. (loc. cit., 156). From Latin indomitus, unrestrained, in reference to the ability of this bacteriophage to increase after heat treatment of infected appres.

Common name : Bacillus mycoides bac-

teriophage.
Host: Bacillus mycordes Flügge, some

strains
Insusceptible species: Bacillus cereus
Frankland and Frankland, B. subtilis
Cohn emend. Prazmowski, B. megatherium De Bary, B. anthracis Cohn
emend. Koth. Some strains of B. mycoides.

Geographical distribution. United

Induced disease: Large plaques, with some secondary growth of host organism.

Thermal inactivation: In vitre, at 75° C in 10 minutes. Spores from infected cultures, heated at 90° C for 10 minutes give

no bacteriophage on grinding, but lytic cultures when grown.

Literature: Lewis and Worley, Jour. Bact., 52, 1936, 195-198.

27. Phagus subvertens H. (loc. cit, 156). From Latin subverters, to subvert, in reference to suspected action of this bacteriophage in causing running-out of alfalfa fields through destruction of nodule organisms.

Common name: Rhizobium legumino-

sarum bacteriophage.

Host: Rhizolium leguminosarum Frank. It has been shown that this bacteriophage is unable to incresse in clover roots without the nodule-forming organism, R. leguminosarum, and that the bacteriophage plays no obviously essential role in nodule formation.

Induced discase: Very small plaques, with edges not sharply defined.

Thermal inactivation: At 60° C in 30 minutes.

Other properties: Not inactivated by drying for 2 months.

Literature: Gerretsen et al, Cent. I. Bakt., II Abt., 60, 1923, 311-3316, Grijas, bid., 71, 1927, 219-221; Hitchen, Jour. Bact., 19, 1930, 191-201; Vandecaveye and Katznelson, Jour. Bact., 51, 1933, 465-477.

28. Phagus ineptus H. (loc. cit., 157).
From Latin ineptus, unsuitable, in reference to inability of this bacteriophage to adapt itself to lysis of strain RW of its host.

Common name : Streptococcus bacterio-

Host: Streptococcus cremoris Orla-Jensen, strain R.

Insusceptible species: Streptococcus

cremoris, strain RW.
Geographical distribution: New Zea-

land.
Induced disease: Plaques 0,25 to 06

mm in diameter. Serological relationships: Antisem specific for streptococcus bacteriophage RW and Chalmers, Shigella dysenteriae Castellani and Chalmers, Shigella gallinarum Weldin, Salmonella typhosa White.

Induced disease: Small plaques with sharp edges, or moderately large plaques with characteristic halo.

Immunological relationships: Member of Resistance Group B, host individuals that have acquired resistance to this bacteriophage are resistant to lines 18, 28, 31, 31, and 38, but ausceptible to Sadmonella entertitus bacteriophages 1, 20, and 11, as well as to other strains of Resistance Groups A, C, and

Literature: Burnet, Jour. Path and Bact., 52, 1929, 15-42.

22. Phagus tertius II (loc cit, 151) From Latin tertius, third, in reference to the third Resistance Group of Salmonella enteritidis bacteriophages, Group C, typified by this bacteriophage.

Common names: Salmonella enteretidis bacteriophage 20, 25, 32, 35, Group C incteriophages.

Hosts Salmonella enterctides Castellant and Chalmers, S. gallinarum Bergey et al., Shigella dysenteriae Castellant and

Chalmers
Induced disease. Plaques of small size, with sharp edges.

Immunological relationships Member of Resistance Group C. Host andividuals that have acquired resistance to this bacteriophage are resistant to lines 25, 35, and 32, but susceptible to Salmontla entertituds Incteriophages of Resistance Groups A, B, and D.

Laterature: Burnet, Jour Patic and Bact., 32, 1929, t5-12

23 Phagus dubtus II (for cit., 155) From Latin dubius, doubtful, in reference to ancertuinty of distinction between Resistance Groups C and D

Common names Sulmonella enteratulis bacteriophage 11, 13, Group D bacterio places

Hosts Salmonella enteritidis Castellam and Chalmers, Shigella dysenteriae Cas tellani and Chalmers, Shigella gallinarum Weldin.

Induced disease: Very large plaques, up to 8 mm in diameter on 1.2 per cent agar

Immunological relationships: Member of Resistance Group D. Host individuals that have acquired resistance to this bacteriophage are resistant to line 13, but susceptible to Salmonella entertitids bacteriophages of Resistance Groups A, B, and C.

Laterature Burnet, Jour. Path. and Bact., 32, 1929, 15-42

24. Phagus Indicens spec. nov. From Latin indicere, to disclose or undicate, in reference to diagnostic use of this bacteriophage in identifying V forms of the typhoid bacillus

Common name Phage Q151.

Host: Salmonella typhosa White (=

Bacillus typhosus Zopf).
Insusceptible species: W forms of the typhoid organism and various Salmonella

species.

Geographical distribution, Canada.

Induced disease In Salmonella typhon, small plaque formation (lysis) and complete inhibition of growth in cultures of the V form (bearing Vi untigen; resisting O agalutinishin) and no lysis or restraining effect on growth of the W form (lacking Vi antigen, agalutinated by O antiserum). In the presence of the virus, mixed cultures are quickly transformed since only W ariants can increase. Pure V cultures can be identified by the test for their complete inhibition, this inhibition is regularly followed by secondary growth representing the pure W form of the boot, a result beginning the pure W form of the boot, a result beginning the pure W form of the boot, a result beginning the pure W form of the boot, a result beginning the pure W form of the boot, a result beginning the pure W form of the boot, a result beginning the pure w form of the boot, a result beginning the pure w form of the boot, a result beginning the pure W form of the boot, a result beginning the pure W form of the boot, a result beginning the pure W form of the boot, a result beginning the pure W form of the boot, a result beginning the pure W form of the boot, a result beginning the pure W form of the boot, a result beginning the pure W form of the boot and the pure W form of the pure W

Filtersbilty Passes Seitz EK filter.

Other properties. Liltrates active in dilutions to 10<sup>-1</sup> or 10<sup>-14</sup>.

Laterature: Craigie, Jour. Ruct., 31, 1936, 56 (Abst.); Craigie and Brandon, Jour. Path and Buct., 43, 1936, 233-248, 249-260

bacteriophage to remain viable under certain adverse conditions.

Common name ; Streptococcus bacteriophage C.

Hosts: Streptococcus 646, 594, 756, 806. Geographical distribution: United States (Ohio, Massachusetts, Connecticut).

Induced disease: Small plaques, the largest about 1.0 mm in diameter.

Serological relationships: Specific neutralization, but no cross reactions with streptococcus bacteriophages A, B, and D.

Thermal inactivation: At 63° to 65° C in I hour.

Other properties: Withstands storage in 1:200 phenol at about 5° C for at least 101 days; equally resistant to storage in 1:10,000 sodium ethyl mercurithiocalicy-late (merthiolate), or to storage without preservatives.

Laterature: Evans, U. S. Pub. Health Ser., Public Health Reports, 49, 1934, . 1388-1401.

33. Phagus michiganensis spec. nov. From name of state, Michigan, where this batteriophase was first isolated.

Common name : Streptococcus bacteriouhage D.

Host : Streptococcus 693.

Geographical distribution: United States (Michigan)

Induced disease. Small plaques, about 0.75 mm in diameter, edges clear-cut, centers clean.

Serological relationships: Specific neutralization, but no cross neutralization with streptococcus bacteriophages A, B, and C.

Thermal mactivation. At 60° to 63° C

in 1 hour. Other properties: Withstands storage

at about 5°C for at least 261 days.

Literature. Evans, U. S. Pub Health
Ser., Public Health Reports, 49, 1934,
1386-1401.

Phagus fragilis, H (loc. cit, 159).
 From Latin fragilis, fragile, in reference

to easy destruction of this bacteriophage by light and by concentrated urea solutions.

Common names: Staphylococcus becteriophage Au2, Au3, Au4, or D, perhaps bacteriophage H of Gratia.

Hosts: Staphylococcus aureus Rosenbach and Staphylococcus albus Hosenbach Geographical distribution: Umted States.

Induced disease: Small plaques, 02 to 1.0 mm in duameter, with sharp edges

Scrological relationships: Cross-neutralization reactions with staphylococcus bacteriophages Aul, Au3, Au4, and D, but not with staphylococcus bacteriophages Au22, Au12, A, B, C, or bacteriophage C16.

Thermal inactivation: At about 57° C in 20 minutes.

Other properties: Particle diameter 50 to 75 millimicrons. Readily inactivated photodynamically. Completely inactivated by 27 per cent urea solution in 1 hour at 37° C. Lysis not inhibited eten by 15 per cent sodium entrate in agar medium.

Literature: Burnet and Lush, Jour Path, and Bact., 40, 1985, 485-499; Burnet and McKie, Austral, Jour. Exp Biol and Med. Sci., 8, 1929, 21-31; Tisk, Jour. Inf. Dis., 71, 1942, 153-150.

35. Phagus intermedius II (lot. et., 169). From Latin intermedius, later mediate, in referent to position of this bacterophage between staphyloroccus bacteriophages that multiply readily in hooth cultures of host organisms and those that do not.

Common name: Staphylococcus lucteriophage Au21.

Host: Staphylococcus aureus Rosen-

Geographical distribution: Australia. Induced disease: Small plaques, 01 to

63 rum in diameter, with sharp edges. Scrological relationships: Specific neutralization reaction but no cross-neutralization reaction with staphylococcus bacteriophages Au2 or Au12. and its strain RWI are ineffective in neutralizing this bacteriophage.

Immunological relationships: Cultures of host-strain R, after exposure to this bacteriophage, furnish subcultures only partly resistant to this bacteriophage and completely susceptible to streptococcus bacteriophage RW and its substrain RWI.

Literature: Whitehead and Hunter, Jour. Path and Bact., 44, 1937, 337-317

29. Phagus streptococci II (loc cit, 158) From generic name of host.

Common name · Streptococcus bacterioplage RW

Host Streptococcus eremores Orla-Jensen, strain RW

Geographical distribution New Zea-

Induced disease Plaques 0.25 to 0 6 mm in diameter.

Thermal mactivation. At 70° to 75° C, time not recorded, probably 30 minutes (nH 60)

Laterature Whitehead and Hunter, Jour Path and Bact., 44, 1937, 337-317 Strous One variant has been described

and distinguished from the type variety, typicus II (loc cit., 158):

- 29a Phoque atreptococci var cirilis II (loc cit, 155). Prom Latin cirilis, vagorous Common name: Stram IWI of
  atreptococcus bacteriophage RW. Differing from the type variety in being able
  to increase at the expense of string RWI
  of Streptococcus cremoris (Whitehead and
  Illunter, Jour Path and Bact., 44, 1937,
  337-347)
- 30 Phagus maculans apec nor From Latin maculare, to speckle, in reference to tiny pluques produced by this bacterioplace

Common name Streptococcus Incterrophage A

Hosta Streptococcus 640, 751, 775
Geographical distribution: United
States (Massachusetts)

Induced disease: Plaques exceedingly

minute, scarcely visible to the unaided

Scrological relationships: Specific antisers neutralize but there is no cross reaction with respect to streptococcus bacteriophase B. C. or D.

Thermal insctivation. At 60° C in 1 hour

Other properties: Withstands storage at about 5° C for at least 145 days with but little loss of virulence.

Literature: Evans, Science, 80, 1934, 40-41; U.S.P.H.S., Public Health Reports, 49, 1934, 1386-1401

31 Phagus lacerans spec, nor. From Latin lacerare, to tear, in reference to ragged edges of plaques produced by this bacteriophage.

Common name: Streptococcus bacteriophage B

Hosta Streptococcus 563,639; Streptococcus mucosus Howard and Perkins.

Insusceptible species: Streptococcus eryspelatos Rosenbach.

Cogmphical distribution: United States (Wisconsin).

Induced disease Medium size plaques, the largest about 3 mm in diameter, edges rarged, centers clean.

Serological relationships: Specific neutralization, but no cross reactions with streptococcus bacteriophages A, C, and D.

Thermal inactivation: At 60° C in I hour

Other properties. Withstands storage at about 5° C for at least 261 days

Literature Clark and Clark, Jour. Bact, 11, 1902, 89; Proc. Soc. Exp. Biol. and Med., 24, 1927, 635-639; Colvin, Jour. Int. Das., 84, 1932, 17-29; Uvans, U.S.P.H.S., Public Health Reports, 49, 1934, 1336-1401, Jour. Bact, 59, 1940, 207-601; Sharatman, Jour. Exp. Med., 44, 1927, 497-500

32 Phagus tolerans spec noc. From Latin tolerans, tolerating, in reference to the unusual ability of this streptococcus and McKie, Austral. Jour. Exp. Biol. and Mcd. Sci., 6, 1929, 21-31.

39. Phagus durabilis H. (loc. cit., 162). From Latin durabilis, lasting, in reference to the stability of this bacteriophage in concentrated urea solution and other unfavorable media.

Common name: Staphylococcus bacteriophage C.

Host: Staphylococcus albua Rosenbach. Coographical distribution: Australia. Induced disease: Plaques 2.0 to 3.0 mm in diameter. Vitreous change in pe-

ripheral zone.

Serological relationships: Cross-neutralization reaction with staphylococcus bacteriophage C', and less strongly with B, but not with Au2 or A.

Immunological relationships: Colonies of Staphylococcus obbus appearing after lysis with this hacteriophage furnish organisms resistant to it but susceptible to staphylococcus bacteriophages A, B, and D.

Thermal inactivation. At 61° to 63° C in 30 minutes.

Other properties Not readily inactivated photodynamically; not completely inactivated by 27 per cent urca solution in 1 hour at 37° C; lysis not inhibited even by 1.5 per cent sodium citrate in agar medium.

Literature: Burnet and Lusb, Jour. Path. and Bact., 40, 1935, 455-469; Burnet and McKie, Austral. Jour. Exp. Biol. and Med Sci., 6, 1929, 21-31; Rakieten et sl., Jour. Bact, 52, 1936, 505-518.

40. Phagus liber H. (loc cit., 163). From Latin liber, independent, in reference to demonstrated independence of this virus, its bacterial host, and its dipterous superhost, in respect to origin

Common name · Staphylococcus muscae bacteriophage.

Host: Staphylococcus muscae Glaser. Geographical distribution: United States

Induced disease: Lysis in broth cul-

tures; plaques in agar cultures, but characteristics of plaques not recorded.

Thermal inactivation: At a little above 50° C in 5 minutes.

Other properties: A characteristic nucleoprotein bas been isolated from lysed staphylococci. Sedimentation constant, 650 × 10<sup>-11</sup> cm dyner's sec. 7; corresponding to a molecular weight of about 360,000,000 Denatured at acidities beyond pH 5 0. Digested by chymotrypsin, not by trypsin. Apparent desity, about 1.20. Diffusion coefficient, varying with dilution.

Literature: Glaser, Amer. Jour. Ilygiene, 27, 1938, 311-315; Northrop, Jour. Gen. Physiol., 21, 1938, 335-366; Shope, Jour. Exp. Med., 45, 1927, 1937-1044, Wyckoff, Jour. Gen. Physiol., 21, 1938.

367-373.

41. Phagus cholerae H. (loc. cit., 164) From former name of host.

Common name: Vibrio commo bacteriophage.

Host: Vibrio comma Winalow et al (Iormerly V. choleroe Neisser); Indias strains usually carry this bacteriopfage, but Chinese and Japanese strains lack it, are ausceptible, and upon inoculation become Ivsocenie.

Geographical distribution: India.

Induced disease: In both R and S forms of Vibric comma, no plaques on ordinary agar plates, but vibros become lysogenic. Egg white in 1:25 dilution enhances activity enough to allow visible lysis, occasional plaques, or atippling at the site of inoculation.

Immunological relationships. Vibra comma organisms that have been infected with this bacteriophage and are resistant to its further action are still susceptible to cholera bacteriophages A, C, and D.

Literature White, Jour. Path. and Bact., 44, 1937, 276-278

42. Phagus celer H. (loc. cit, 164). From Latin celer, quick, in reference to relatively quick action of this bacteriophage.

Other properties: Not readily inactivated photodynamically; completely innetivated by 27 per cent urea solution in 1 hour at 37° C; lysis inhibited by 1 per cent sodium extrate in agar medium but not by 05 per cent or lower concentrations.

Literature: Burnet and Lush, Jour Path and Bact., 40, 1935, 455-469

36. Phagus caducus H. (loc cit, 160) From Latin cadicus, perishable, in reference to the easy destruction of this bacteriophage by concentrated urea solutions.

Common name: Staphylococcus baeteriophage Au12.

Host, Staphylacoccus aureus Rosenbaeli

Coographical distribution: Australia Induced disease Small plaques, 0.2 to 0.5 mm in diameter, with sharp edges

Serological relationships: Cross-neuimilization reactions with staphylococcus lacterrophages AuT1 and AuT3, but not with staphylococcus bacterrophages Au2, Au21, A, and C. Antiserum to staphylococcus hacterrophage B gives no neutralization of AuT2, though the reciprocal renetion occurs to 1 200 dulution.

Other properties. Not readily inactivated photody annically, completely inactivated by 27 per cent urea solution in 1 hour at 37°C, lysis inhibited by as hitle as 0.25 per cent sodium citrate in agar.

Literature Burnet and Lush, Jour Path and Bact , 40, 1935, 455-469

37 Phagus aipha II (loc cit., 161) From Greek equivalent of common name Common name Staphylococcus Ineteriophage A

Host Staphylococcus albus Rosenbach Geographical distribution. Australia Induced disease. Plaques of medium size, 15 to 25 mm in diameter, with hary periphery.

Serological relationships. Specific neutralization reaction, but no cross neutralization reactions with staphylococcus lacteriorilages Au2, B, or C Immunological relationships: Colonies of Staphylococcus albus appearing after lysis with this bacteriophage are resistant to staphylococcus bacteriophages B, C, and D.

Thermal inactivation: At 68° to 70° C in 30 manutes.

Other properties: Not readily inactivated photodynamically; not completely mactivated by 27 per cent urea solution in 1 hourst 37° C, lysis not inhibited even by 1 5 per cent sodium citrate in agar.

Literature. Burnet and Lush, Jour. Path and Bact., 40, 1935, 455-469, Burnet and McKie, Austral. Jour. Exp. Biol. and Med Sci., 6, 1929, 21-31.

33. Phagus beta II. (loc. cit., 162).
I'rom Greek equivalent of common name.
Common name. Staphylogoccus bacterionhage B.

Host · Staphylococcus albus Rosenbach. Geographical distribution: Australia.

Geographical distribution: Australia. Induced disease Plaques of medium size, 07 to 15 mm in illameter, with sharp edges

Serological relationships. Specific neutralization reaction, but no cross-neutralization reaction with cross-neutralization reaction with respect to staphylococcus bacteriophages Au2, Au12, Au7 C, except that antiserum made with Au12 neutralizes this bacteriophage in low dibutions (See Phagus caducus).

Immunological relationships: Colonies appearing after lysis of Slaphylococcus albus with this becteriophage furnish organisms susceptible to staphylococcus laterrophages A and D

Thermal mactivation At 63° to 65° C in 10 minutes.

Other properties Readily inactivated photodynamically; completely inactivated by 27 per cent urea solution in I hour at 37 °C, lysis not inhibited even by 1.5 per cent sodium citrate in agar medium.

Laterature Burnet and Lush, Jour. Path and Bact., 49, 1935, 455-469; Burnet Potato: Rich, creamy spreading growth.

Indole not formed.

Nitrites not produced from nitrates.
Ammonia is produced.

Acid from glucose, maltose, starcb, glycerol and mannitol. No acid from lactose or sucrose.

Cellulose is attacked.

Aerobic, facultative.

Optimum temperature 20°G.

Source: Isolated from soils in Utah. Habitat: Soil.

Sa. Pseudomanas effusa var. non-liquefaciens Kellerman et al (loc. ext.). A non-liquefying variety that acts more slowly on litmus milk.

Source: Soils from Utah.

9. Pseudomonas reptilivorous Caldwell and Ryerson. (Jour. Bact., 39, 1949, 335.) From Latin, reptile, a reptile and voro, to devour, destroy.

Rods. 0 5 by 1 5 and 2 0 microns, occurring singly, in pairs and in short chains and having rounded ends Actively mottle with two to six polar flagella. Gram-accativa

Gelatin colonies. After 24 hours, small, circular, smooth, entire. Liquefaction with a yellowish-green fluorescence.

Gelatin stab Infundibuliform liquefaction becoming stratiform. Putrid odor present.

Agar cultures: Circular, smooth, glistening, slightly raised, butyrous, translucent, 2 mm in diameter.

Agar slant: Growth abundant, smooth, filiform, glistening, butyrous and translucent.

Broth Turbid with pellicle and sediment. Putrid odor.

nent. Putrid odor. Litmus milk: Alkaline, peptonization,

complete reduction Disagreeable odor Potato. Growth moderate, spreading, glistening, yellowisb-gray to creamy. Disagreeable odor Medium becomes brownisb-gray.

Indole not formed.

Nitrates not produced from nitrates.

Hydrogen sulfide not produced.

Slightly acid, becoming alkaline in glucose. No acid from arabinose, xylose, lactose, sucrose, maltose, trehalose, raffinose, mannitol, dulcitol, inositol and salicin.

Stareb not hydrolyzed.

Pathogenic for guinea pigs and rabbits, horned lizards, Gila monsters and chuckwallas.

Temperature relations: Optimum 20° to 25°C. Maximum 37°G.

Distinctive characters: Yellowisbgreen fluorescence present in meat infusion media. Pathogenic.

Source: Isolated in a bacterial disease of horned lizards and Gila monsters. Habitat: Pathogenic for lizards.

10. Pseudomonss syncysnea (Ehrenberg) Migula. (Vibrio syncyancus Ehrenberg, Berichte u.d. Verh. d. k. Preuss. Akad d Wissensch. z. Berlin, 5, 1840, 202; Vibrio cyanogenes Fuchs, Magazin für die gesamte Tierheilkunde, 7, 1811, 190; Bacillus syncyaneus Schroeter, Kryptogam. Flora von Schlesien, 3, 1, 1886, 157; Bacillus cyanogenus Zopf, Die Spaltpilze, 3 Aufl., 1885, 86; Migula, in Engler and Prantl, Die natürl. Pflanzenfam., 1, 1a, 1805, 29, Bacterium syncyaneum Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 275; Pseudomonas cyanogenes Holland, Jour. Bact., 5, 1920, 224) From Greek, sun, with: Luaneos, dark blue, dark.

Rods with rounded ends, occurring singly, occasionally in chains, 0.7 by 2.0 to 4.0 microns. Motile with two to four polar flagella. Gram-negative.

Gelatin colonies · Flat, bluish, translucent.

Gelatin stab: Surface growth shiny, grayish blue. The medium is colored steel-blue with greenish fluorescence. Gelatin is liquessed. Some strains do not liquesy.

Agar slant: Grayish-wbite streak. The medium takes on a bluish-gray color with slight fluorescence. Common name: Cholera bacteriophage A.

Host. Vibrio comma Winslow et al, smooth types, except non-agglutinable vibrios.

Geographical distribution: India

Induced disease, Lysis in 2 hours, folloned by abundant secondary growth Only smooth elements of the culture are attacked

Serological relationships Antigenically distinct from cholera bacteriophage C

Immunological relationships Secondary growth resistant to this virus, but susceptible to cholera bacteriophages C and D

Other properties Selectively mactivated by specific polyacecharide of smooth strains, not by a lipoid emulsion that is effective against cholers bacterio-phage C. Active in dilution of 1 10° or 1 10° Multiplication rate, n × 10° in 2 hours

Literature Ashcehov et al , Indian Jour Med Res , 20, 1933, 1127-1167, White, Jour Path and Bact , 45, 1930, 591-593

43 Phagus effrenus II. (loc cit, 165) From Latin effectus, unbridled, in reference to the ability of this bacteriophage to attack all tested strains of the cholemographism

Common name Cholera Insternaplage C

Host. Vibrio comma Winslow et al , all

strains Geographical distribution India.

Induced disease Sometimes death without lysis. When lysis occurs, it is rarely complete and is followed by secondary resistant growth.

Serological relationships Antigenically distinct from cholera incirrophage A

Immunological relationships Second ary growth resistant to this bacterio phage, but susceptible to cholera facterophages A and D

Other properties Selectively masts vated by lipsoid from smooth atrain of best, but not by specific polysacelande Active in dilution of 1:10\* or 1:10\*
Multiplication rate, n × 10\* in 2 hours,

Literature: Asheshov et al., Indian Jour. Med. Res , 20, 1933, 1127-1157; White, Jour. Path. and Bact., 45, 1936, 591-503

44 Phagus lentus H. (loc. cit., 166) From Latin lentus, slow, in reference to the relatively slow and incomplete lysis induced by this bacteriophage.

Common name Cholera bacteriophage D.

Host · Vibrio comma Winslow et al

Induced disease Incomplete lysis in about 5 hours, followed, in rough cultures, by slow development of resistant accordary growth

Immunological relationships Secondary growth resistant to this bacteriophage, but susceptible to cholem bacteriophages A and C.

Other properties Not inactivated by specific polysacelands effective against cholera bacteriophage A, nor by lipoid effective against cholera bacteriophage C Multipheation rate, n × 10<sup>4</sup> in 2 hours.

Literature Asheshov et al., Indian Jour Med. Res., 50, 1933, 1127-1157; White, Jour Path. and Bret., 45, 1936, 591-593.

45 Phagus diphtherise II (foe cit., 167). From name of heet

Common name Corynebacterium diphtheriae bacteriophage

flost Corputacterium diphtherine Lehmann and Neumann, many straine, especially 122 of 127 Australian type II gracis isolates, type I gracis isolates are lysogs are (extricts), all intermediate isolates are succentible.

Insusceptible species Cosymbatesium diphibersus, all tested mits inslates, except 2 lympone. A strain of C diphtherate from Swan Hell, 200 miles north of Melkourne, was found to be resistant to this bacterophage and to the small plaque diphtheria bacteriophage, P. futilis.

Geographical distribution: Australia,

Induced disease: In Corynebacterium diphtheriae on agar, plaques 1.0 to 1.5 mm in diameter, with shelving edge. A few resistant bacterial colonies often appear in the central clear area.

Literature: Keogh et al., Jour. Path. and Bact., 46, 1938, 565-570; Smith and Jordan, Jour. Bact., 21, 1931, 75-88; Stone and Hobby, Jour. Bact., 27, 1934, 403-117.

46. Phagus futilis H. (loc. cit., 168). From Latin futilis, vain, in reference to regular appearance of resistant organisms in plaques on agar cultures lysed by this bacteriophage.

Common name: Small-plaque diphtheria bacteriophage.

Host: Corynebacterium diphtheriae Lehmann and Neumann, gravis type I isolates and all but 5 gravis type II isolates.

Insusceptible species: All tested intermediate and mitis strains of C. diphtheriae.

Geographical distribution: Australia

Induced disease: In Corynebacterium diphtheriae on agar, pin-point plaques or confluent plaques, with confluent growth of accondary, resistant organisms.

Literature: Keogh et al., Jour. Path. and Bact., 46, 1938, 565-570.

#### Suborder II. Phytophagineae subordo novus.

Viruses infecting higher plants; vectors typically homopterous or hemipterous insects (leafhoppers, aphids, white flies, true bugs) or thysanopterous insects (thirps). From Greek phagein, to cat, and phyton, a plant.

#### Key to the families of suborder Phytophaginese.

- Inducing yellows-type diseases, vectors typically cicadellid or fulgorid leafhoppers.
  - Family I Chlorogenaceae, p 1145.
- Inducing mosaic diseases; vectors typically aphids.
   Family II. Marmoraceae, p.1163.
- 3. Inducing ringspot diseases; vectors unknown,
  - Family III. Annulaceae, p. 1212.
- 4 Inducing leaf-curl diseases, vectors typically white flies. Family IV. Rugacege, p 1218.
- 5 Inducing leaf-gavoying diseases, vectors, true bugs. Family V. Saroigeeae, p. 1221.
- 6 Inducing spotted wilt, vectors, thrips.

  Family VI. Lethaceae, p. 1223

### FAMILY I. CHLOROGENACEAE HOLMES EMEND.

(Randb. Phytopath. Viruses, 1939, 1.)

#### DELLIDAE and FULGORIDAE)

## Key to the genera of family Chlorogenaceae.

- I True Yellows Group Viruses inducing diseases usually characterized by estimulation of normally dormant and adventitious builts to produce numerous slender shoots with long internodes and by chlorosis without spetting; invaded parts abnormally erret to habit. Vectors cleadeflid feathoppers so far as known.
  - Genus I. Chlorogenus, p 1116
- Peach X-Disease Group Viruses inducing diseases characterized by rosetting of foliage and sometimes death of lost

Genus II. Carpophthora, p 1151

- III Phloem-Necrosis Group. Viruses inducing diseases characterized by progressive disceneration of the best plant or by wilting and midden death; cometimes by root discoloration. Vectors escadellid leafhoppers so far as known.
  - Genus III. Moraus, p. 1153
  - Yellow-Dwarf Group Viruses inducing diseases characterized by chlorotic effects somewhat resembling true mottling but often more diffuse. Vectors cical-dilid (spillian) leafliopiers
    - Genus IV. Aureogenus, p 1151.
  - V. Un-Dieses Group. Viruses inducing discuses characterized by marked vascular proliferation. The sector of one is known to be a leafloopper of the subfamily Delphacinae, family FULGORIDAE. Genus V. Gello, p. 1157.

VI. Stripe-Disease Group. Viruses inducing diseases characterized by chlorotic striping; hosts grasses. Vectors, cleadellid and fulgorid leafhoppers. Genus VI. Fractilinea, p. 1159.

# Genus I. Chlorogenus Holmes.

## (Loc. cit., 1.)

Viruses of the Typical Yellows Group, inducing diseases usually characterized by stimulation of normally dormant and adventitious buds to produce numerous slender shoots with long internodes, by chlorosis without spotting, or by both growth of numerous slender shoots and chlorosis. Invaded parts abnormally erect in habit. Affected flowers often virescent. Hosts, dicotyledonous plants. Vectors, so far as known, exclusively cicadellid leafhoppers. Generic name from Greek chloros, light green or yellow, and suffix, gen, signifying producing, from Greek genos, descent,

The type species is Chlorogenus callistephi Holmes.

# Key to the species of genus Chlorogenus.

- I. Natural hosts many, in various families of plants.
  - 1. Chlorogenus callistephi. 2. Chlorogenus australiensis.
- II. Known natural hosts relatively few.
  - A. Natural hosts resaceous.
  - B. Natural hosts solanaccous.
  - C. Natural host sandal.
  - D. Natural host cranberry.
  - E. Natural bost locust
  - F. Natural host alfalfa
  - G. Natural host hop.

- 3. Chlorogenus persicae.
- 4 Chlorogenus solani.
- 5. Chlorogenus santali.
- 6. Chlorogenus vaccinii.
- 7. Chlorogenus robiniae
- 8. Chloropenus medicaginis.
- 9 Chloragenus humuli.

 Chlorogenus callistephi Holmes. (Handb. Phytopath Viruses, 1939, 2.) From New Latin Callistephus, generic name of the China aster.

Common names: Aster-yellows virus, lettuce white-heart virus, Erigeron-yellows virus.

Hosts: Callistophus chinensis Nees, the China aster, is the host that has been studied most. 170 or more species in 38 different families of dicotyledonous plants have been shown susceptible. Lettuce, endive, carrot, buckwheat, parsnip, and New Zealand spinach are among the hosts of economic importance

Insusceptible species. All tested species of the family Leguminosae and some species of all other tested families have appeared naturally immune

Geographical distribution: U. S., Canada, Bermuda, Japan, and Hungary. In California the celery-yellows strain of this virus replaces the type.

Induced disease: In most host species the characteristics of disease are clearing of veins, followed by chlorosis of newly formed tissues, stimulation of normally dormant buds to growth, malformation, virescence of flowers, sterility, and upright growth habit. Stimulation of nor

mally dormant buds to adventitious growth and abnormally erect halut are the most constant features. Chlorosis is absent or inconscieuous in some bests.

Transmission · By leafhopper, Macrosteles divisus (Uhl ) (= Cicadula sexnotata (Fall ), C. ditisa (Uhl )) (CICA-DELLIDAE). Incubation about 2 weeks. Some strains of this virus are transmitted also by the leafhoppera Thampotettix montanus Van D and T geminatus Van D. (CICADELLIDAE) By grafting By dodder. Not through seeds of diseased plants. Not by mechanical inoculation of plants, but virus has been passed from insect to insect mechanically in Macrosteles divisus, Juice from viruliferous insects contains little virus just after inoculation, but the effective concentration increases at least 100-fold between the 2nd and 12th day of a 17-day incubation period, at seems greatest before the insects begin to infect the aster plants on which they are maintained

Thermal inactivation. In pure from viruliferous insects, at about 40° C in 10 minutes, at 25° C in 2 to 3 hours. In plant tissues, at 33° to 42° C, in 2 to 3 weeks, cured plants fully susceptible to reinfection. In insect vector, M. diresus, at 31° C in 12 days.

Other properties Virus in juices derived from insects is more stable at 0° C than at 25° C or when frozen; at 0° C it withstands storage 21, not 4°, hours in 0 85 per cent NaCl solution at pl 17.0 but most of the virus is inactivated in this time; it withstands dilution 1:1000 in neutral 0.85 per cent NaCl solution, for brief (less than 5-minute) expoures, it remains viable over the range from pl 5 to 9.

Literature. Black, Phytopath, \$1, 1911, 120-135; 33, 1913, 2 (Abat.); Johnson, 15d., 34, 1911, 619-605; Kunkel, Am. Jour Bot, 15, 1926, 616-705; Contrib Boyce Thompson 1-st. 5, 1911, 85-123, 4, 1932, 405-327; 29, 1911, 761-709; Linn, Cornell Agr. Lips, 18a, 14(Lacs.), Bull.

742, 1940; Ogilvie, Bermuda Dept. Agr., Agr Bull 6, 1927, 7-8; Severin, Hilgardia, 5, 1929, 513-853; Phytopath., 20, 1930, 920-921; Hilgardia, 7, 1932, 163-179; 8, 1934, 308-325, 303-301; Phytopath., 30, 1940, 1019-1031; Hilgardia, 14, 1942, 411-440; Severin and Haasis, Hilgardia, 8, 1934, 323-335.

Strains. Two variant strains, one found in nature, the other derived experimentally, have been given varietal names to distinguish them from the type variety, rulgaris II (loc. cit, 2):

In. Chlorogenus collistephs var. colliorneus II. (Oc. cit., 3) From Collioria, name of state in which this strain was first recognized Common name Celery-yellous strain of aster-yellows virus. Differing from the type variety by ability to infect celery (Apium gracelons L— UMBELLIFERAE) and zinnia (Zinnia degons Jacq—COMPOSITAE) (Kunkel, Contrib Boyco Thompson Inst., 4, 1902, 463–414, Severin, Illigardia, 5, 1929, 543–5835, 8, 1934, 305–325).

1b Chlorogenus callistephs var. attenuatus II. (Ico. cit. 4). Irom Latin attenuatus, weakened Common name: Ileat-sattenuated atumn of aster-yellowa virus Differing from the type variety by inducing (eas rever chlorosis and less uprightness of new growth in affected aster plants (Kunkel, Am. Jour. Bot., 24, 1997, 316-327).

 Chlarogenus austrattensis comb. nor. From Australia, name of continent. Synonym. Galla australiensis 11 (loc. cit. 107)

Common names: Tomato hig-bud virus; virerence virus; perhaps also stowlesor virus, tobacco stollour or montar virus, eggplant intile-lent virus.

Hosts: SOLANACEAE—Datura straromium L., Jumon weed; Lycopersicon scendentum Mill, tomato; Nicotiona talacum L., tobarco; Solamur riclompena L., egglunt; S. nigrum I., black nightshade. Berentija horg int of species in this and other families have been reported as ausceptible to virescence virus, presumed to be an isolate of tomato big-bud virus. (Hill, Jour. Counc. Sci. Ind. Res., 16, 1943, 85-22).

Geographical distribution: Australia, especially New South Walea; viruses causing somewhat similar diseases have been reported also from the Crimea and the northwestern United States.

Induced disease: In tomato, flowers erect, virescent, calyx bladder-like, pollen sterile; floral proliferation. Growth of axillary shoots stimulated. leaves progressively smaller. Youngest leaves yellowish-green in color, especially at their margins; usually purplish underneath. Hypertrophy of inner phloem. No intracellular inclusions. Fruit reddens imperfectly and becomes touch and woody. Roots appear normal. In Solanum nigrum, axillary shoots numerous, leaves small, internal phloem adventitious. In tobacco, plants dwarfed; leaves recurved, distorted, twisted, thickened, brittle, yellowish green, hanging down close to stem; small leaves on shoots from axillary buds; proliferation and virescence of flowering parts; chlorotic clearing of veins as early effect of disease; upper surface of foliage appears glazed; some necrosis of veins, in old leaves, near taps and margins or on midrib; viable seed rarely produced; calvx bladder-like, floral axis may form short branches bearing small leaves; disease sometimes called bunchy top.

Transmission: By leafhopper, Thannotettic argentata Evans (CICADELLI-DAE). Experimentally by budding and other methods of grafting. Not by moculation of expressed june.

Literature: Cobb, Agr. Gaz. New South Wates, 13, 1902, 410-414; Dana, Phytopath, 30, 1910, 893-893; Hill, Jour. Austral. Inst. Agr. Sci. 6, 1940, 199-200; Jour. Copucil Sci. Ind. Res., 10, 1937, 309-312; 16, 1943, 85-92; Michailowa, Phytopath, 25, 1935, 539-558; Rischkov t al., Zischt. Pflanzenkr, 43, 1933, 496498; Samuel et al., Phytopath., 23, 1933, 641-653.

3. Chlorogenus persicae H. (loc. cit., 5). From New Latin Persica, former generic name of peach.

Common names: Peach-yellows virus, little-peach virus.

Hosts: ROSACEAE—Prunus persuca (L.) Batsch, peach; P. salicina Lindi., Japanese plum; and all other tested species of the genus Prunus.

Geographical distribution: Eastern United States and Canada, south to North Carolina. First occurred near Philadelphia in this country. Origin perhaps oriental; introduction in oriental rlums suspected. Not in Europe.

Induced disease: In peach, clearing of veins, production of thin erect shoots bearing small chlorotic leaves, followed by death in a year or two. In early stages of the disease there is premature riponing of fruit. In Japanese plum, systemic infection but no obvious symptoms

Transmission: By the leafnepper, Macropsus trimoculata (Extch) (CICADEL-LIDAE). By budding; virus spread down stem from point of bud insertion faster than up. Not by inoculation of expressed juice, despite numerous attempts. Not by pollen of diseased trees.

Immunological relationships: Presence of peach-yellows virus immunizes tree against little-peach virus, formerly considered an independent c tity.

Thermal inactivation fn peach tissues, at 34° to 35° C in 4 to 5 days; at 44° C in 30 minutes, at 47° G in 10 minutes; at 50° C in 3 to 4 minutes; at 50° C in 15 seconds.

Other properties Trees and bud sticks may be treated safely with heat sufficient to kill the virus. Cured trees are susceptible to reinfection.

Literature: Blake, N. J. Agr. Exp. Sta., Bull. 226, 1919; Kunkel, Contrib. Boyce Thompson Inst., 5, 1933, 19-28; Phytopath., 25, 1936, 201-219, S09-S30, 23, 1933, 491-497; Manns, Trans. Peninsula Hort-Soc, 23, 1933, 17-19; Manns and Manns, ıbid., 24, 1934, 72-76, McCubbin, Pennsylvania Dept. Agr., Gen. Bull. 382, 1921

Strains: Numerous strains of peachyellows virus probably exist in nature One of these has been given a varietal name, distinguishing it from the type variety, tulgaris II. (loc. cil., 5):

3a. Chlorogenus persicae var. micropersica II. (loc. cit , 6). From Greek micros, small, and New Latin Persica, former generic name of peach. Common name Little-peach strain of peach-yellows virus. Differing from the type variety by tendency to cause a mild type of disease, characterized by distortion of young leaves, production of many short branches on main trunk, later yellowing of mature leaves, twiggy growth, shoots slightly less creet than in typical peach yellows (Kunkel, Phytopath., 26, 1936, 201-219, 20, 1930, 809-830; 28, 1938, 491-497, Manns, Trans. Peninsula Hort Soc , 25, 1933, 17-19; 24, 1931, 72-76 )

Chlorogenus solani II (loc cit, 7)
 Prom New Latin Solanum, generie designation of potato. Synonym: Chlorophthora solani McKinney, Jour Washington Acad. Sci., 54, 1914, 151.

Common names: Potato witches'-broom virus, potato wilding or semi-wilding virus.

Hosts: SOLAN ACCAE—Solanum tuberosum L., potato. Experimentally, nlso SOLAN ACCAE—Lycopersion esculentum Mill., tomato; Nicotiana tobacum l., tobacco; N. glutinosa L.; N. rustica L. JPOCI NACEAE—Vinca rorea L., priwinkle. CHENOPODIACEAE— Beta rulgans 1, sugar beet.

Geographical distribution: United States (Montana, Washington), Russia

Induced disease: In potato, increasingly pronounced flave-scence in new leaflets on one or more stems, production of new dwarfeil leaflets with marginal flave-cence on stems with unusually long interpodes and enlarged nodes, growth of standing availiety, and lived branches profuse blooming and fruiting, lack of dormancy in tuber buds, formation of many small underground tubers as well as some aerial tubers; plants grown from diseased tubers form thread-like stems and small simple leaves; infected plants survive several seasons, with progressive degeneration In tomato, experimentally, extreme leaf dwarfing, marginal flavescence of leaves and abnormally numerous axillary branches, stems become hollow and die; plants do not survive long after infection. In tobacco, experimentally, slender axillary branches with dwarfed leaves, flowers on spindling pedicels, numerous, small, later leaves flaves.

Transmission By tuber-core grafts with prepatent period of 2 to 114 days. By stem grafts. By dodder, Cueruta campestris Yuncker (CONVOLI ULA-CEAE) Not by inoculation of expressed junce Not by Mocrositele divisus (Uhl) (CICADELIDAE). No insect vector is known Not through seeds of directed tomatical transmission of the control of the co

cent or marginally flavescent

Thermal mactivation at 42° C in 13 days, in tissues of Vinca roses; at 36° C in 6 days in small potato tubers.

Laterature Hungerford and Dana, Phytopath, 14, 1921, 372-383, Kunkel, in Virus Diseases, Cornell Univ Press, Ithaca, N. Y. 1913, 63-82; Proc. Am. Philosoph Soc. 66, 1913, 470-475, Me. Larty, Scient Agr. 6, 1926, 395, Whipple, Montina Agr. Exp. Sta. Bull 130, 1919; Young, Seenee, 66, 1927, 304-306; Am. Jour. Bot. 16, 1929, 237-279, Young and Morris, Jour Agr. Res. 56, 1929, 833-851.

5 Chlorogenus santali II. (loc. cit., 6). From New Latin Santalum, generic designation of sandal

Common names Sandal spike-disease virus, sandal spike-rosette virus.

Hosts SANTALACEAE—Santalum album L., sandal Spike-like diseases lave been found also in RHAMNEAE— Zizyphus conoplia Mill, SAPINDA-CEAE—Dolanaca rurora Jucq VIR.  Inducing rosette formation characteristically, but not tattering of affected foliage.

 Carpophthora lacerans (Holmes) McKinney. (Marmor lacerans Holmes, Handb. Phytopath. Viruses, 1939, 82;
 McKinney, Jour. Washington Acad. Sci., 34, 1944, 152.) From Latin lacerare, to lacerate, in reference to characteristic foliace injury.

Common name: Peach X-disease virus; virus of peach yellow-red virosis.

Hosts: ROSACEAE—Prunus persica (L.) Batsch, peach; P. virgminna L., chokecherry.

Geographical distribution: United States, Canada.

Induced disease: In peach, foliage normal each spring but yellowish areas anpear in June at base of leaves; affected trees appear lighter green than neighboring healthy trees; discolored spots occur at random on the leaf blade, becoming red and vellow with remainder of leaf becoming chlorotic; the discolored areas usually fall out, leaving the foliage tattered; subsequently, affected leaves drop except at tips of branches; young trees may die. older ones survive indefinitely. Fruit either shrivels and falls or ripens prematurely, with bitter flavor and no viable seed. In chokecherry, conspicuous premature reddening of foliage, development of fruits with dead embryos in the pits, in the second and third seasons after infection, duller colors of foliage, rosettes of small leaves on terminals, death follows the advanced stage of disease.

Transmission: By budding. Not by inoculation of expressed juice. No insect vector has been reported.

Literature: Berkeley, Drv. of Botany and Plant Path, Science Service, Dominion Dept. Agr., Ottawa, Canada, Publication 678, 1941; Royd, U.S. Dept. Agr., Plant Dis. Rep. 22, 1938, 334, Hilde hrand, Contrib. Boyce Thompson Inst., 11, 1941, 485–496; Hildebrand and Palmiter, U.S. Dept. Agr., Plant Dis. Rep., 2. Carpophthora recettae.

22, 1838, 394-396; Hildebrand et al., Handbook of virus diseases of stone fruits in North America, Michigan Agr. Exp. Sta., Alise, Publ., 1942, 21-24; Stoddard, Connecticut Agr. Exp. Sta., Circ. 122, 1938, 54-60; Proc. Connecticut Pomel. Soc., 18, 1938, 29-32.

2. Carpophthora rosettae (Holmes) comb. nes. (Chlorogenus rosettae II, nomen nudum, Phytopath. 19, 1029, 43; Nanus rosettae II., Handb. Phytopath. Viruses, 1939, 125.) From rosette, common name of induced disease, from French, diminutive of rose, a rose.

Common name: Peach-rosette virus. Hosts: ROSACEAE-Prunus persica (L.) Batsch, peach : P. communis Fritsch. almond; P. domestica L., plum. Experialso-APOCYNACEAEmentally. Vinca rosea L., periwinkle, ROSA-CEAE-P. americana Marsh., wild plum, P. armeniaca L., apricot; P. cerasus L., cherry; P. pumila L. sand cherry. SOLANACEAE-Lycoperation esculentum Mill., tomato; Nicotiana glutmosa L Geographical distribution: United States (Georgia, Alabama, South Carohna, Tennessee, West Virginia, Missouri, Oklahoma).

Induced disease: In peach, sudden wilting and death, or growth of absormally short stems bearing dwarfed leaves with clearing and thickening of veins, followed by death in a few months.

Transmission: By budding. By dodder, Cuzcula compestris Yuneker. Not by inoculation of expressed juice. Not through soil. No insect vector is known. Immunological relationships: No protain is developed by newylong infection.

Immunological relationships: No protection is alforded by previous infection of peach trees with Chlorogenus persical, peach-yellous virus.
Thermal inactivation: At 50° C in 10

Thermal inactivation: At 50°C in to minutes (in tissues of peach). Resetted trees are abnormally susceptible to heat injury and heat treatments cure peachrosette disease only in recently inlected trees.

Literature: Kunkel, Phytopath, 26, 1936, 201-219, 809-830; in Virus Diseases,

Cornell Univ. Press, Ithaca, N. Y, 1943, 63-62; McClintock, Jour. Agr. Res., 24, 1923, 307-316, Phytopath., 21, 1931, 373-356, Smith, U. S. Dept. Agr., Div. Veg. Path., Bull. 1, 1891.

## Genus III. Morsus gen nov

Alfalfa-Dwarf Group, viruses inducing diseases characterized in general by sudden witting and death or by gradual decline of vigor with foliage of darker green color than normal. Vectors, like those of the typical yellows subgroup, candellid leafthoppers so far as known. Generic name from Latin morsus, sting or vexation. The type species is Morsus suffedient spec, nos.

Key to the species of genus Morsus.

- I. Affecting alfalfa and grape
- II. Affecting tobacco.
- III. Affecting elm.
- Morsus suffodiens spec. nov. From Latin suffodere, to sup or undermine, in reference to process leading to sudden collapse of long infected, but sometimes not obviously injured, grape vines as well as to progressive decline in size of infected aliala plants, the foliage of which

may remain green to the last Common names: Alfalfa-dwarf virus, lucerne dwarf-disease virus, virus of Pierce's disease of the grape, virus of Anaheim disease

llosts: LEGUMINOSAE-Medicago satira l., alfalfa (lucerne). VITA-CEAE-Vitis rinifera L., grape.

Geographical distribution United

Induced disease: In alfalfa, leaves small but green, plant progressively smaller, wood of roots alsochered yellow, transpiration decreused; wilting may occur; starch of root diminished, plant eventually succumbs, thinning stand prematurely. In grape, dark green color of leaves retained along veins, not letween them, or no almormality in appearance of foileys; wilting and audden death of plant in summer of second year. In late summer of first year, there may be

- 1 Morsus suffodiens,
- 2. Morsus reprimens.
- 3. Morsus ulms.
- dying leaf margins and dying back of cane

Transmission. By budding and root grating. By leathoppers. Proceulace-phala minersa Ball, Carnecephala fulgida Nott, C traputata Nott, Helockera delta Oman, Neololia circellata (Baker), N. gothica (Sign), N. confuens (Uhler), M. hetroglyphico (Say), and Cuerna occidentata Oman and Beamer (CIGA-DELLIDAE), these vectors all belong to the subfamily Amblycephatines, all texted species of this, but none of any other, subfamily have proved capabile of transmitting thus virus. Not by in-oculation of expressed jince. Not through roll

Laterature Transer, Phytopath, 54, 1911, 100-1001, Heart, Phytopath, 22, 1939, 10, 31, 1911, 862, 100 Anchor, 18, 1911, 16-21, 36, Heartt et al. Phytopath, 52, 1912, 8, Houston et al. Phytopath, 52, 1912, 8, Houston et al. Phytopath, 52, 1912, 10; Mibmith, Calif Dept. Agr., 20th Ann. Bept. Hull. 28, 1916, 671; Pherce, U. S. Dept. of Agr., Div. of Veg Tath., Bull 2, 1872, 1-222; Weimer, Phytopath, 24, 1931, 71-57; 27, 1937, 697-702, Jour. Agr. Res., 47, 1933, 331-265; 28, 1905, 333-347; 83, 1973, 57-10

2. Morsus reprimens spec. nov. From Latin reprimere, to restrain, check, or curb, in reference to the inhibiting effect on growth of the host plant, tobacco.

Common name: Tobacco yellow-dwarf virus.

Hosts: SOLANACEAE—Nicotiana tabacum I., tobacco, N. rustea I., Indian tobacco; N. trigonophylla Dun. Experimentally, also N. glavae Grah. (symptomicss) and N. glutinosa L.

Geographical distribution: Australia (Victoria, New South Wales, South Australia, and southern Queensland).

Induced disease; In tobacco, internodes of stem shortened, leaves small; downward bending of tips and rolling under of margins of young apical leaves; young leaves darker than normal at first, bunched, later appear ribbed; leaves become yellow-green, pale first between vains; old leaves rugose, thickened, later savoyed. Root gystem small, roots slightly brown externally and in the region of the phoem. Affected plants may survive the winter and show diseased new growth in the spring

Transmission By grafting and budding By nymphs and adults of the leafhopper, Thamnotettix argentata (Evans) (CICADELLIDAE).

Literature: Dickson, Australia, Council Sci. Indust. Res., Pamphlet 14, 1929, 22; Hill, Australia, Journal of the Council Sci. Indust. Res., 10, 1937, 228-230; 14, 1941, 181-186; 15, 1942, 13-25.

3. Morsus ulmi spec. nov. From Latin

Common name: Elm phloem-necrosis virus.

Host: URTICACEAE-Ulmus americana L., American elm.

Geographical distribution United States (Ohio, Indiana, Illinois, Missouri, Tennessee, Kentucky, and West Virginia).

Induced disease: In elm, gradual decline over a period of 12 to 18 months before death or sudden witt, drying of leaves, and death within 3 to 4 weeks. All ages susceptible, from seedling to large tree.

Transmission: By patch grafting. Not by inoculation of expressed juice.

Literature: Leach and Valleau, U. S. Dept. Agr., Plant Dis Rept., £3, 1923, 300-301; Swingle, Phytopath., 59, 1940, 23.

# Genus IV. Aureogenus Black.

(Proc. Am. Philos. Soc., 88, 1944, 141.)

Viruses of the Yellow-Dwarf Group, inducing diseases characterized by yellowing without typical mesate-type mottling. Vectors agailian leathoppers (CICADELLI-DAE). Generic name from Latin aureus, yellow or golden, and genus, group.

The type species is Aureogenus vastans (Holmes) Black.

# Key to the species of genus Aureogenus.

- Mechanically transmissible in some hosts by rubbing methods of incentation.
   Not producing enlarged veins or club-leaf in clover.
  - 1. Aureogenus vastans.
- Not known to be transmissible by rubbing methods of inoculation.
   A. Producing enlarged veins in clover
  - 2. Aureogenus magnivens.
  - B. Producing club-leaf in clover.
- 3. Aureogenus clavifolium.

Broth: Turbid with marked fluorescence.

Litmus milk: Unchanged. In association with lactic acid bacteria the milk takes on a deep blue color

Potato: Yellowish-gray, shiny layer, becoming bluish-gray The medium becomes bluish-gray

Indole not formed.

Nitrites not produced from natrates Aerobie, facultative

Optimum temperature 25°C

Habitat: The cause of blue milk

11. Pseudomonas schuylkilliensis Chester. (Bacillus fluorescens schuyl-Ailliensis Wright, Momoirs, Natl Acad Sci., 7, 1895, 448, Chester, Determinative Bact., 1901, 320 ) From M L of the Schuylkill (Rever)

Synonyms: Pseudomonas capsulaia Chester, Man. Determ Bact , 1901, 322 (Bacillus fluorescens capsulatus Pottien, Zischr. f. Hyg., 11, 1896, 140), Pseudo monas dermatogenes Lubrmann, Cent f. Bakt., H Abt , 17, 1906, 356

Short rods, with rounded ends, occurring singly, in pairs and in chains tile, possessing a polar flagellum negative.

Gelatin colonies Grayish-white, trans lucent, with brownish center, radiate margin, becoming bluish green

Gelatin stab: Slow erateriform house faction, with blue green fluorescence Ague elant: Gravish. translucent

growth. Medium shows greenish fluorescent.

Broth: Turbid, with slight pellicle and blue-green fluorescence Stringy sediment.

Litmus milk: Congulated, with slow reduction of himus; pentanized

Potsto: Brownish, spreading, wierid, thick. Indule is formed (trace)

Nitrites not produced from aitrates Acrobic, facultative

Does not grow at 33° to 36°C

Source: Isolated from Schuvlkill Rive water.

Habitat: Water.

12 Pseudomonas chlororaphis (Guignard and Sauvageau) Bergey et al. (Bacillus chlororaphis Guignard and Sauvageau, Compt. rend. Soc. Biol. Paris. 1. 10 ser., 1894, S41; Bergey et al., Manual. 3d ed , 1930, 166; also see Lasseur and Dupair-Lasseur, Trav. Lab. Microbiol Fac Pharm. Nancy, Fasc. 9, 1936, 35.) From Greek, chloros, greenish yellow: raphis, needle

Rods: 0.8 by 1.5 microns, with rounded ends, occurring singly and in pairs. Motile with polar flagella. Gram-negative,

Gelatin colonies. Circular, viscid, transparent, glistening, lobate margin. with fluorescent corona Dissociates readily (Lassour and Dupaix-Lassour, loc cit ).

Gelatin stab. Stratiform liquefaction. Broth. Turbid, fluorescent, with crystals of green, water-soluble chlororaphine.

Litmus milk: Congulation. Pentoniza-Crystals of chlororaphine form in the central part of the culture.

Potato Citron-yellow layer. Crystals of chlororophine are formed

Natrates reduced to nitrates.

Indole not formed Pigment formation Asparagine, potas-

sium phosphate, glycerol, sulfate of magnesium and sulfate of sron are indispensable to the formation of crystals of chlororaphine.

Aerobic, figultative Optimum tempersture 25° to 30°C

Pathogenic for laboratory animals. Exotorin formed

Habitat: Water.

flarella. Gram necative.

13 Pacudomones myrogenes Fuhrmann. (Cent I Pakt, II Abt., 17, 1907, 335) From Greek, myra, mucus, gentad, to larget, M. I. slime producing

Rods - 04 to 0.5 by 10 to 1.5 microns, occurring singly and in rears. Motile, possessing a landle of five to seven roler

Filterability: Passes Berkefeld Wilter.

Other properties: Virus viable at 23 to 27° C less than 13 hours after extraction of juice from diseased plant; not infective after drying in leaf tissues.

Literature: Barrus and Chupp, Phytopath., 12, 1922, 123-132; Black, Am. Potato Jour., 11, 1931, 148-152; Cornell Univ. Agr. Exp. Sta., Mem. 209, 1937, 1-23; Phytopath., 28, 1938, 863-874; Am. Jour Bot., 27, 1940, 386-392; Am. Potato Jour., 18, 1911, 231-233; Phytopath., 53, 1913, 363-371; Genetics, 28, 1913, 200-209; Proc. Am. Philos. Soc., 83, 1911, 132-144; Hansing, Cornell Univ. Agr. Exp. Sta., Bull. 792, 1913; Price and Black, Am. Jour. Bot , 28, 1911, 591-595; Taylor, Am. Potato Jour., 16, 1938, 37-40; Walker and Larson, Jour. Agr Res., 59, 1939, 259-280; Watkins, Jour. Econ Ent. \$2, 1939, 561-564; Cornell Univ. Agr. Exp. Sta , Bull. 758, 1911, 1-21; Younkin, Am, Potato Jour . 19, 1912, 6-11.

Strains: Beside the type variety, Aureogenus rasians var. vulgare Black (Am. Jour. Bot , 27, 1940, 391), on which the species is based, two distinctive strains have been given varietal names:

la. Aureogenus vastans var. agaltiae Black. (Am Potato Jour , 18, 1911, 233.) From New Latin Agallia, generic name of vector of this strain Common name: New Jersey strain of potato yellow-dwarf virus Differing from the type especially in its distinctive vector, the leafhopper, Agallia constricta Van Duzce, which is incapable of transmitting the type strain, and in not being transmitted by Aceratagallia sanguinolenta (Provancher), common vector of the type variety Experimentally, transmitted also by Agallia quadripunctata (Provancher), perhaps rarely by Agalliopsis novella (Say), Differing but little from the type in effects on potato (var Green Mountain) and Nicotiana rustica but more definitely in effects on crimson clover, in affected plants of which a rusty-brown necrosis

along the veins, not induced by the type strain, is always present in some degree.

th. Aurcogenus vastans var. lethate Black. (Am. Jour. Bot., 27, 1940, 391.) From Latin lethalis, causing dath. Common name: Strain B5 of potato yellow-dwarf virus. Differing from the type variety especially in a tendency to induce in Nicotiana rustica, experimentally, brown primary lesions with necroit gray centers, systemic yellowing, extensive necrosis of veins, collapse of large areas of leaf, and sometimes death of the host; not known to occur in nature as a esparate strain, but readily isolated as a variant from strains collected in nature.

2. Aureogenus magnivena Biack. (Proc. Am. Philos. Soc., 88, 1944, 144.) From Latin magnus, large, and vena, vein. Common name: Clover big-vein virus.

Host: Experimentally, LEGUMINO-SAE-Trifolium incarnatum L., crimson clover.

Insusceptible species: SOLANA-CEAE—Nicotiana rustica L, Indian tobace: Solanum tuberosum L., potate.

Geographical distribution: United States (presumably, Washington, D. C).

Induced disease: In crimson clover, experimentally, unevenly thickened veins which are depressed below the upper surface of the leaf; these enlarged veins, best observed from below, sometimes bear enations that arise from their lower surfaces, leaves often curl upward and inward marginally, in summer, yellowing of leaves progresses from margins inward, the yellow color being later replaced in part by red or purple red; petioles undulating; plants dwarfed; internodes shortened; no clearing of veins, no rusty-brown necrosis.

Transmission: Not by inoculation of expressed junce. By leafhoppers, Agdinopass noedle (Sey), Agdila constructs Van Durce, A quadripunctata (Provancher) (TCADELLIDAE).

1. Aureogenus vastans (Holmes)
Black (Marmor castans Holmes,
Handlb Phytopath. Viruses, 1939, 94;
Black, Proc. Am. Philos. Soc. 83, 1944,
141.) From Latin rastare, to devastate

Common name: Potato yellow-dwarf

Hosts: SOLANACEAL—Solanum tubersum L., potato COMPOSITAL— Chrysanthenum leuconthemum L., var. punnathfulm Lecoq and Lamotte, daisy; Rudhecha hurta L., black-eyed Susan. CRUCIFERIAE—Barbarca eulgoris R. Br., common winter cress. LEGU-MINOSAE—Trifolium pratense L., red clover Experimentally to numerous species in these and other families.

Geographical distribution: Northeastern United States and southeastern

Canada.

Induced disease: In potato, yellowing of leaves, necrosis of stem, dwarfing of plant, the stem, if split, shows rusty specks especially at nodes and apex; the aney dies early, tubers are few, small, close to the atem, often cracked, with flesh discolored by scattered brown specks, seed tubers tend to remain unrotted in the ground, becoming hard and classy, some of them do not germinate in warm soil, others produce shoots that die before reaching the surface, giving toor stands In Chrisunthemum feueanthemum var pinnatifidum, at first, clearing of seins, later, young leaves distorted, thick, stiff. small; petioles short, leaves erect, forming a rosette at the crown of the plant, with passing of the early places of the disease, foliage tends to مواسية والمستسومة فيستناه

and after the period of obvious disease and infected plants may constitute an important reservor. In Trifolium incoraction 1, crimoon obver, experimenally, clearing of veins and yelloning of yourger leaves (in number the yellosing is usually replaced in gart by an interveinal reddish-brown color on both leaf surfaces extending from the margins inwards); dwarfing of entire plant; death or a chronic disease characterized by milder manifestations without, however, vein enlargement or cupping of leaves. In Nicotiona rustica L., experimentally, yelfowish primary lesions followed by clearing of veins and systemic chlorosis; the primary lesions facilitate quantitative estimations of concentrations of this vivias.

Transmission: By inoculation of expressed juice, in the presence of finely powdered carborundum, to Nicotiano sustica: mechanical transmission very difficult in other hosts tested. By graft. ing. By clover leafhopper. Aceratacollia sanguinofenta (Provancher): experimentally, by other closely related leafhoppers. Accratagallia lurata (Baker), A. obscura Oman, and A currate Oman; not (for the type variety of the virus) by Apallia constricta Van Duzee, very rarely by Agallia auadripunctata (Provancher) and Apalliopsis norella (Say) (CICADELLI-DAE). The vector Accratagallia sanquinofenta remains infective as an overwintering adult; incubation period not less than 6 days, commonly much longer; virus does not ross to progeny of viruliferous leafhoppers through eggs or sperm; this leafhopper varies genetically in ability to transmit.

Immunofesical relationships: No protection is afforded against necrotic effects
of a testing atrain of this virus (var.
lethale Black) by prior inoculation of
Nicotonan vartea with isolates of Marror
medicagini, M. cucumeris, M. upaston,
Annalus tabaci, A. one, or A. dubius,
but the varacties rulgare Black and agaltine Black protect; these specifically protecting strains rive no similar protection
against formation of recrotic lesions by
subsequently applied isolates of Marror
takaca, M. let) ale, Annalus tabaci, or A.

Thermal inactivation: At 50 to 52° C in 10 monutes.

Ser. 3, 1924, 99-107; Lyon, ibid., 5, 1921, 1-43; Hawaiian Planters' Rec. 12, 1915, 200; Mungomery and Bell, Queenaland, Bur. Sugar Exp. Sta., Div. Path , Bull. 4, 1933; Octemia, Am. Jour. Bot., 21, 1921, 1931, 1931.

2. Galla queensiandiensis H. (loc. cit., 103). From Queensland, where the induced disease was first studied

Common name: Sugar-cane dwarf-diacase virus.

Host: GRAMINEAE-Saccharum officinarum L., sugar cane.

Geographical distribution: Queensland, Induced disease: In sugar cane, young leaves marked with scattered chlorotic streaks, leaves stiff and erect, spindle twisted, abnormally short and pale. As leaves mature, streaks disappear, leaves become darker than normal green. In recently infected plants, vascular bundles are enlarged, irregular in shape, fused and characterized by abnormal proliferation of thin-walled lignified cells.

Literature: Bell, Qucensland, Bur. Sugar Exp. Sta, Div Path, Bull. 3, 1932.

3. Galla anemones H. (loc cit., 108). From Latin anemone, anemone or windflower.

Common name: Anemone-alloiophylly

Hosts: RANUNCULACEAE—Anemone nemorosa L., vernal windflower; A ranunculoides L., A trifolia L.

Geographical distribution Germany.

Induced disease: Leaves thickened and distorted, petioles thickened. Flowers distorted or not formed. Vascular bundles larger and more numerous than in healthy plants. Palisade cells short, chloroplasts smaller and fewer than normal.

Transmission. By needle puncture into rhizomes immersed in filtered juice of diseased plant. By contamination of soil with fragments of diseased leaves or rhizomes.

Literature: Klehahn, Bericht. d Deutsch. Bot. Gesellsch., 16, 1837, 527-536; Zischr. wissensch. Biol., Abt. E., Planta, 1, 1926, 419-440; 6, 1923, 40-95; Phytopath. Zischr., 4, 1932, 1-36; 9, 1936, 337-376.

4. Galla verrucae Biodgett. (Phytopath., 35, 1943, 30). From Latin erruca, wart. Originally spelled verruca, apparently by a typographical error, which was corrected twice on the following page, once in a statement that the genitive verrucae had been given as specific epithet.

Common name : Peach-wart virus.

Host: ROSACEAE-Prunus persica

(L.) Batsch, peach.

Geographical distribution: United

States (Idaho, Washington, Oregon).
Induced disease: In peach, no characteristic effect on foliage. Fruits bilistored, wellted, later with warty outgrowths conspicuously raised. Affected tissues light tan to red, rough, cracked and russeted, or smooth. Genuming usual, often severe. Worty tissue superficial; underlying tissues coarse, filed with gum pookets, but not abnormal in flavor. Werty tissue may be hard and bony, but more often it is merely tougher than normal.

Transmission: By budding and inarching.

Literature: Blodgett, Phytopath., 51, 1911, 859-860 (Abst.); 53, 1943, 21-32.

5. Galla zeze McKinney. (Jour. Washington Acad. ' i, 54, 1944, 228) From Latin zea, a kind of grain

Common name: Wallaby-ear disease

Virus
Host: GRAMINEAE-Zea mays L.

corn (maize).

Geographical distribution: Southeastern Queensland, Australia.

Induced disease. In corn (maite), small swellings on secondary vend on undersides of young leaves, spreading these and tip of leaf along veins; plant dwarfed, becoming abnormally deep read and deficient in development of police, silk, cobs, and grain retarded in growth.

Black 3. Aureogenus clavifolium (Proc. Am Philos. Soc., 83, 1914, 141.) From Latin clara, club, and folium, leaf.

Common name : Clover club-leaf virus. Host . Experimentally, LEGUMINO-SAE-Trifolium incarnatum la, crimson clover.

Insusceptible species: SOLANA-CEAE-Nicotiana rustica L., Indian tobacco , Solanum tuberosum L , polato.

Geographical distribution: United States (Princeton, N. J.).

Induced disease : In crimson clover, experimentally, youngest leaves lighter green than normal, slow to unfold; leaf margins yellowed or colored red or purple red; affected leaves narrow, smooth or savoved; plant dwarfed, new shoots from leaf axis slightly stimulated; new growth of spindly stems and small leaves; no rusty-brown necrosis of veins, no obvious enlargement of veins, and no obvious clearing of veins at the onset of disease.

Transmission: Not by inoculation of expressed juice. By leafhopper, Agalhopers norella (Sav) (CICADELLI-DAE); not by leafhoppers, Accratagailia sangunglenta (Provancher). Agalfia constricta Van Duzee, nor A. quadripunctata (Provancher) (CICADELLIDAE).

# Genus V. Galla Holmes

(Loc. cit., 106)

Viruses of the l'in-Disease Group, inducing diseases characterized by vascular proliferation. Generic name from Latin gella, a rall nut

The type species is Galla finensis Holmes

Key to the species of genus Galla.

1 Infecting sugar cane.

\ Inducing formation of conspicuous galls.

I Galla finensis.

B Not inducing formation of conspicuous galls. 2. Galla queenslandiensis

II Infecting anemone

3 Galla anemones.

III Infecting peach.

4. Galla terrucac.

IV Infecting corn.

5. Galla zear

! Galla filiensis Holmes (Handb Phytopath Viruses, 1939, 106 ) From

name of Fur Islands Common name l'in-desease virus

Host GRAMINEAE-Saccharum officongrum f. . sugar cane

Geographical distribution : Fin Islands, New South Wales, Java, Philippine Is lands, New Guines and New Caledonia

Induced disease. In sugar case, galls on vaccular bundles, formed by problem tion of phloem and nearby cells. M feeted cells show characteristic spherical or aval inclusion bedies. Developing leaves shortened, enumpled, abnormalla

dark green. Infected stools of case become lurby. Boots small, bunchy

Transmission, By leaflioppers, Perkinsielfa saccharicida Kirk (in Queensland) and P. rastatrez Bredebn (in Philippine Islands) (FULGORIDAE, pubfamily Delphacinar) Not by grafting. Not by moculation of expressed juice. Not through eggs of P rustatrix. Cut. tings taken from affected capes produce some health; and some diseased plants, became signail we not become uniformly distributed throughout the bost transca-

Laterature Knokel, Bull I ap Sta . Hawanan Sugar Planters' Assoc. Bot.

maize-streak virus. Differing from the type strain in being specialized for attacking sugar cane, in which the type (from maize) tends to be localized or finally lost with resultant spontaneous recovery of the temporary host. The cane-streak strain usually spreads readily in the cane plant; leaves become much marked with broken, narrow, pale, longitudinal stripes and spots; stems remain unaffected. One variety of sugar cane, POJ 213, is resistant and, if infected, tends to recover. (McClean, Intern. Soc Sugar Cane Techn., Bull. 27, 1932; Proc. So. Afr. Sugar Techn. Assoc., 1936. 1-11; Storey, Rept. Imp Bot. Conf., London, 1924, 132-144; Union So. Afr. Dept. Agr , Sci. Bull. 39, 1935 , Ann Appl. Biol., 17, 1930, 691-719.

1b Fractilinea maidis var. mitis H. (loc. cit., 58). From Latin mitis, mild. Common name: Mottle strain of maize-streak virus. Differing from the typical strain by the mildness of the disease induced in corn (maize), transitory chlorotic mottling of newly developed leaves, followed by fading of mottling and production of apparently normal leaves Young leaves, while mottled, are less rigid than normal and may not remain as nearly erect as healthy leaves (Storey, Ann. Appl. Biol., 24, 1937, 87-94)

2. Fractilinea oryzae (Holmes) comb. nov. (Marmor oryzae Holmes, loc cit, 64.) From Latin oryza, rice.

Common name: Rice dwarf-disease

Hosts. GRAMINEAE—Oryza satura L, rice. Experimentally, also Alopecurus fulus L, Arena satura L, oat, Echinochloa crusgalli Beauv var. edules Honda, Panicum miticecum L; Poa pratensis L; Secale cercale L., rye; Triticum vulgare Vill, wheat

Insusceptible species: GRAMINEAE

—Zea mays L, corn (maizo); Hordeum
vulgare L., barley; Setaria italica Beauv.,

fortail millet; Andropogon sorghum Brot. (= Holcus sorghum L.), sorghum.

Geographical distribution: Japan, Philippine Islands.

Induced disease: In rice, yellowish green spots along veins of young leaf, followed by chlorotic spotting and streaking of subsequently formed leaves. Growth atunted, internodes and roots abnormally short, forming a dwarf plant. Vacuolate intracellular bodies, 3 to 10 by 2.5 to 8.5 microns in size, close to nuclei of cells in affected tissues.

Transmission: By leafhoppers, Nephotellix apicalis var. cincticeps Uhler, N. bipunctatus Fabr., and Deltocephalus dorsalis Motsch. (CICADELLIDAE). Virus transmitted through some of the eggs but through none of the sperm of infected individuals of N. apicalis. Transfer from individuals thus infected through the egg to their progeny likewise demonstrated, even to the 7th generation. This is the only confirmed instance of transmission of a phytopathogenic virus through the eggs of an insect vector and is considered as evidence that the virus multiplies within the body of its vectorss well as in its plant hosts. Incubation period in insect usually 30 to 45 days after first feeding on an infected plant, sometimes as short as 10 or as long as 73 days; nymphs from viruliferous eggs do not become infective until 7 to 38 (average 19) days after emergence. Transmission by inoculation of expressed juice has not been demonstrated. No transmission through seeds from diseased rice plants. No soil transmission.

Literature: Agati et al., Philippine Jour. Agr., 12, 1941, 197-210; Falushi Trans. Sapporo Nat. Hist. Soc., 12, 1931, 35-41; Proc. Imp. Aead., Tokyo, 3, 1933, 457-100; Jour. Fac. Agr. Hokkaido Imp Univ., 37, 1934, 41-164; Trans. Sapporo Nat. Hist. Soc., 15, 1934, 162-168; Proc. Imp. Aead., Tokyo, 11, 1935, 301-303; 15, 1937, 328-331; 15, 1939, 142-145; Jour. Fac. Agr. Hokkaido Imp. Univ. 45, 1940, 83-151; Katsura, Phytogath. Transmission: By leafliopper, Cicadula bimaculata Evans (CICADELLIDAE) Literature: Schindler, Jour. Austral. Inst. Agr. Sci., 8, 1942, 35-37.

#### Genus VI. Fractilinea McKinney.

(Jour. Washington Acad. Sci., 34, 1944, 148.)

Viruses of the Stripe-Disease Group; hosts grasses; insect vectors, cleadellid and Iulgorid leafhoppers Generic name from Latin, meaning interrupted and line.

The type species is Fractilinea maids (Holmes) Mckinney.

#### Key to the species of genus Fractilinea.

- I. Vectors, cicadellid leafhoppers.
- 1. Fractilinea maidis.
- 2. Fractilinea oryzae.
- 3. Fraclilinea tritici.
- 4. Frachlinea quarta.
  II. Vectors, Iulgorid lealhoppers
  - 5 Fractilinea zege.
  - 6. Fracislinea arenae.
- 1. Fractilinea maidis (Holmes) Mc-Kinney (Murmar maidis Holmes, Handb Phytopath Viruses, 1939, 56, Fractilinea maidis McKinney, Jour.

Washington Acad Sci, 34, 1914, 149) From New Latin mays, corn (i.e. maize) Common name: Maize-streak virus

Hosts: GRAMINEAE—Zea mays L., corn (msuc); Digitaria haricontalis Willd, Elevine indica Gaert, Saccharum officinarum L. sucy cape.

Geographical distribution Africa

Induced disease. In corn, pole spots at base of young leaf, followed by chlorotte spotting and strewking of subsequently formed leases. Virus moves spodly tup to 40 cm in 2 hours at 30° C) after introduction into fiest plant by insect. More virus in chlorotte spots than in green areas of affected leaves.

Transmerion By hethoppers, Creathina (e. Richtha) which (Naude), C tree China, and C storey China (CLC.). DELLIDAE: In C which ability to transmit this virus is controlled by a seedlinked dominant gene, active male (AN) (Y), insertive male (AN) (Y), insertive male (AN), active female (

is wounded purposely or accidentally. Il moculated artificially by introducing virus into blood, both active and inactive masets become infective. Inculation period, 6 to 12 hours at 30° C. Young not infected through the rgs. Infective leaf-hopper cannot transmit virus unless feeding planeture exceeds a minimum period, about 5 minutes in duration. This virus has not been transmitted to its plant boots by inoculation of expressed juices.

Filteralality, At pH 6, passes Chamberland In and In, Berkeleldt V and N, filters, returned by Seatz I' K filter disc.
Literature: Storey, Ann. Appl., Biol., 12, 1923, 422-437, 15, 1923, 1-25, 196, 102, 15, 1976.
Lis., 1934, 633-455; 125, 1931, 583-569; 24, 1937, 587-91, 124, 1934, 588-569; 24, 1937, 587-91, 1244 Aff. Agr. Dour., f, 1736, 471-475, Storry and McClenn, Ann. Appl., Biol., fr, 1930, 691-479.

Strains. Two strains that differ radically from the type, var. typicum II. (loc cd., 50), have been given varietal names, as follows

is Fractifined models var. succeeds: il. theorem, 57) From New Latin Succeedsrum, generic name of sugar cane. Common name: Cane-streak strain of

sect is usually between 11 and 23 days, although shorter periods have been demonstrated in a few cases. Virus may persist in the insect host until death, but may become exhausted earlier. Not by aphid, Aphis madis Fitch (APHIDI-DAE). Not by inoculation of expressed inice

Literature: Briton-Jones, Trop. Agr., 10, 1933, 119-122; Carter, Ann. Ent. Soc. Am., 54, 1941, 551-556; Kunkel, Bull. Hawaiian Sugar Flanters' Assoc., Bot. Ser., 5, 1921, 44-57; 1924, 108-114; Hawaiian Planters' Rec., 26, 1922, 55-61; Phytopath., 17, 1927, 41 (Abst.); Stahl, Trop. Pl. Res Found., Bull. 7, 1927; Storey, Rept. of Plant Pathologist, Amani Agr. Res Station, 4th Ann. Reot., 1931-32, 30 5-13

6. Fractilinea avenue McKinney (Jour. Washington Acad Sci., \$4, 1944, 327.) From Latin arena, oats

Common name: Pupation-disease virus.

Hosts: GRAMINEAE—Avena satira
L, oat; Triticum acstivum L., wheat;

Echinochloa crusgalli Beauv.; Setaria viridis; rarely, Apopyron repens (L.) Beauv. and Bromus inermis Leyas Experimentally, also Hordeum vulgare L., barley; Panicum miliaceum L., millet; Orysa astira L., rice; Secale cereale L., tye; Zea mays L., corn (maire).

Geographical distribution: West Siberia.

Induced disease In act, chloretic mottling, profuse development of shoots, proliferation of flowers with change to leaf-like structures. Protein crystals in affected cells have been regarded as necumulated virus.

Transmission: By leafhopper, Delphaz striatella Tallan (FULGORIDAE), especially first and second instar mymbys. Bith instar nearly immune to infection. Incubation period, 8 days or more. Virus overwinters in insect as well as in plants. Not transmitted from an infected leafhopper to its progeny. Not through seil. Not through seeds from infected plants.

Literaturo: Sukhov et al., Compt. rend. Acad. Sci., U. R. S. S., 20, 1938, 745-748, 26, 1940, 479-482, 483-485. 22, 1936, 8SF-895; Takata, Jour. Japan Agr. Soc., 471, 1895, 1-4, 172, 1896, 13-22 (Takata's papers, in Japaness, constitute the first published record of transmission by an insect of a virus causing disease in a plant, the leafhopper Dellocephalus dorsolis Motech, tumsmitting dwarf-disease virus to rice; see Fukushi, 1937, cited above).

3 Fractilinea tritlel McKinney. (Jour. Washington Acad Sci., 54, 1944, 327.) From Latin tribeum, wheat

Common name. Winter-wheat mosaic

Hosts GRAMINEAE—Triticum aestirum L, wheat; Secale cercale L, ryc, Arena byzantina; A. fotua L, wild oat, A. satua L, oat, Hordeum rulgare L, barley.

Geographical distribution Union of Soviet Socialist Republics.

Induced disease: In winter wheat and rye, ellorotic mottling; profuse branching. In winter wheat, phloem necrosis, chloroplasts few, small; vacuolate inclusions in cells; nuclei enlarged and with extm nucleoli, no protein crystals of the puption-disease type in affected cells In spring wheat, lurley, and cats, chlorotic mottling without profuse branching, no proliferation of flowers, but grant is rarely formed, most infected plants dying before this stage of growth.

Tmnsmission: By leafhopper, Delto exphalus strictus L. (CLC.) DELLIDAE, with incubation period of 15 to 18 days. Not by inoculation of expressed junce. Not through soil

Laterature. Zazlurilo and Situhova, Compt rend. Acad Sec. U. R. S. S., \$5, 1939, 798-801; \$26, 1910, 474-478, \$29, 1910, 429-432, Proc. Lenin Acad. Arr. Sec., U. H. S. S. 6, 1911, 27-29 [Hev. Appl. Myc., 19, 1910, 208; \$0, 1911, 157, 396, \$2, 1917, 50]

4 Fractilines quarts (Holmes) comb nor (Marmor quartum Holmes, loc est., 65) From Latin quartus, fourth Common name: Sugar-cane chloroticstreak virus or fourth-disease virus.

Host: GRAMINEAE-Saccharum officinarum L, sugar canc.

Geographical distribution. Java, Queensland, Hawaii, Puerto Rico, Colombia, United States (Louisiana).

Induced disease: In sugar cane, reduction of growth rate; willing at midday; long, narrow, fongitudinal streaks, of creamy or white color, in the leaves Streaks 1/16 to 3/16 inches wide, generally less than I foot long, fragmenting.

Transmission. By leafliopper, Draceulacephala portola Ball (CICADELLI-DAE). Not demonstrated by inoculation of expressed juice.

Thermal Inactivation; In enttings, at 52° C in less than 20 minutes.

Literature: Abbott, Phytopath, 28, 1938, 535-537; Sugar Bull, 16, 1938, 3-4; Abbott and Ingram, Phytopath, 32, 1912, 99-100; Bell, Queensland Agr Jour., 40, 1933, 409-461; Martin, Hawanan Planters' Rec, 34, 1930, 375-378; Hawanian Sugar Planters' Assoc. Proc, 63, 1931, 21-33.

5 Fractilinea zeae (Holmes) comb. nor (Varmor zeae Holmes, loc. cit., 57.) I rom New Latin Zea, generic name for corn (maire), from Latin zea, a kind of grain

Common name Maize-stripe virus.
Host. GRAMINEAE-Zea mays L.,

corn (maize).
Insusceptible species GR.IMINE.1E

Saccharum offernarum L., sugar cane.
 Geographical distribution: Hanai,
 Tanganyaka, Mauntius, Trinidad, Cuba
 Not in United States

Indured disease. In corn (maize), at first fee, clongsted, chlorotic berons near based 3 oung leaf, later enlarging and fusing to form continuous stripes. Subsequently formed leaves handed and striped variously. Vaccidate intracellular inclusions in cells of affected are as

Transmission By leaflopper, Peregranic modes (Aslan) (FULGORI-DAE), the incubation period in this in-

- I. Found in nature principally in solanaceous plants; Cucurbitaceae insusceptible. Chlorotic mottling in some hosts, necrotic lesions in others as result of experimental infection. Suspensions show anisotropy of flow.
  - 1. Marmor tabaci. 2. Marmor constans.
- II. Found in nature only in cucurbitaceous plants; Solanaceae insusceptible. Only mottling as result of experimental infection. Suspensions show marked anisotropy of flow.
  - 3. Marmor astrictum.
- III. Found only in leguminous plants. Chlorotic lesions in some varieties of the common snap-bean plant, necrotic lesions in others, as a result of expenmental infection.
  - 4. Marmor laesiofaciens.
  - IV. Found in greenhouses confined to roots and lower parts of plants. Only necrotic lesions as result of experimental infection. Suspensions do not show anisotropy of flow.
    - 5. Mormor lethale.
    - V. Found in tomato and experimentally transmissible to a number of species of plants in this and other families. Resembling the preceding in a number of physical characteristics, including failure to show anisotropy of flow 5a. Marmor dodecahedron.

l Marmor tabaci Holmes (Holmes. Handb Phytopath Viruses, 1939, 17; Musicum tabaci Valleau, Phytopath , 30, 1940, 822; Phytovirus nicomosaicum Thornberry, Phytopath., \$1, 1941, 23.) From New Latin Tabacum, early generic name for tobacco

Common names : Tobacco-mosaic virus, tomato-mosaic virus.

SOLAN ACEAE-Necotions tabacum L., tobacco; Lycopersicon esculentum Mill, tomato, and Capsicum fruiescens L., garden pepper, amoog crop plants; nearly all, if not all, solanaceous plants can be infected, although in some the virus remains localized at or near the site of inoculation PLANTAGINA-CEAE-A strain of this virus has been found in nature infecting Plantago lanceolala L , ribgrass, P. major L. and P. rugelii Dene., common broad-leaved plantains. Experimental hosts are widely distributed through many related families of plants.

Geographical distribution : World-wide. Induced disease: In most varieties of tobacco, yellowish-green primary icsions, followed by clearing of veins, distortion and greenish-yellow mottling of newly formed leaves. In Ambalema tobacco. no symptoms, virus being restricted to inoculated leaves or those nearby. Strains of tobacco showing necrotic effects have been produced recently. In tomato, no obvious primary lesions, systemic disease characterized by greenishyellow mottling of foliage, moderate distortion of leaf shape, and a reduction of fruit yield not exceeding 50 per cent. If some strain of potato-mottle virus (Marmor dubium) is also present, a more severe disease is induced; this is known as double-virus streak, and is characterized by systemic necrosis. In most varieties of garden pepper, yellowish primary lesions followed by systemic chlorotic mottling In the Tabasco popper and its recent derivatives, recovery by abscission of inoculated leaf, after localization of virus in necrotic primary lesions. Vacuolate intracellular inclusions are found in chlorotic tissues of all hosts that show distinct chlorotic mottling.

Transmission · By slight abrasive contacts By inoculation of expressed juice. To some extent by the aphids, Myous pseudosolani Theob., M. circumfexus (Buckt ), Macrosiphum solanifolii Ashm, and Myzus persicae (Sulz.) (APHIDI-DAE). By grafting. Through soil.

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# FAMILY II. MARMORACEAE HOLMES EMEND

Viruses of the Mosaic Group, inducing diseases usually characterized by persistent viruses of the Mossic Croup, inducing discuss usually engancierized by persistent of chlorotic or necrotic spotting, and often by mottling. The family is here extended to include several small groups of viruses, formerly assigned independent family rank, include feveral small groups of viruses, formerly assigned undependent family rank, about the but sharing a tendency to aphild transmission, so far as known, and inducing disease. but snatting a tenuency to apinu transmission, so far as above, and mutering diseases that characterized by abnormal growth labit, thickening and folling of leaves, or dwarfing, confractivities of the amount from the adult, thickening and roung of leaves, or dwarfing, traits not incompatible with the characters of the present group. Should any one of traits not incompatible with the characters of the present Kruup. Should any one of these small groups become the center of a large assemblage of new virtues in the future, these small groups occome the center of a large assemblage of new viruses in the turne, separate familial status for it might again be advantageous. In the combined groupseparate immina status for it might again we suvantageous. In the commined in here used, specific vectors, so far as known, are aphids (APIIIDIDAE)

I Viruses of the Typical Mosue Disease Group.

Genus I Marmor, p. 1163

II Viruses of the Spindle-Tuber Group Genus II Aerogenus, p 1202

III Viruses of the Ical-Roll Group

Genus III. Corium, p 1203

IV Viruses of the Dwarf-Disease Group

V Viruses of the Rough Bark Group Rimocortius, p 1208

VI Viruses of the Symptomiess Group. Adelonosus, P 1211 Genus VI

## Genus I Marmor Holmes

Viruses inducing typical mosaic diseases in various plants. Generic name from

Latin marmor, a mottled substance The type species is Marmor labaci Halmes

A Relatively regutant to hert mactivation, usually requiring more than 10 It Relatively susceptible to heat macutation, requiring less than 10 minutes at minutes of \$5 to 90° (\* for complete inactivation

a Replacing pulsio sembanding arms in mixed infections 2 Tolmeco-Litch Virus Group

an Not replacing totalo sembinding virus in mired infections 3 Cucumber Moraic Virus Group.

C Many additional species cannot 3rt be grouped into definite subdivisions of

the genus, they constitute a residual or

Ley to the species of the Tokacco Motoric Virus Group Viruses relatively renorant to less mactivation, requiring in most cases more than Viruses relatively resistant to fest inscription, requiring in most excess more than 10 minutes at NS to 90° C for complete inscription — Insert vectors as yet unknown. under natural conditions

ابر نوا Pz1

,,1

Gelatin colonies: Smooth, soft, slat, spreading, entire, yellowish-green. Gelatin stab: Growth along stab.

Liquefaction with yellowish-white sedi-

Agar colonies: Gircular, raised, smooth, amorphous, entire. Agar slant: Yellowish white, moist,

glistening, becoming light green-fluorescent.

Broth: Turbid, with yellowish-white sediment. Litmus milk: Flocculent precipitation.

Slow peptonization with yellow serum. Alkaline.

Potato: Dirty yellow to olive, most, glistening, entire.

Indole is formed.

Nitrates reduced to nitrates and ammonia. No gas formed

Aerobic, facultative Optimum temperature 22°G.

Source Isolated from beer

 Pseudomonas septica Bergey et al. (Bacillus fluorescens septicus Stutzer and Wsorow, Cent. f. Bakt., II Abt., 71, 1927, 113; Bergey et al , Manual, 3rd ed., 1930, 169.) From Greek, septikos, putrefactive, septic

Rods 0 6 to 0 8 by 0.8 to 20 microns, occurring singly. Motile with a polar

flagellum Gram-negative.

Gelatin stab Infundibuliform lique-

faction.
Agar colonies: Circular with opalescent

center and transparent periphery
Agar slant Moderate, undulate margin.

Broth: Turbid with fragile pellicle, greenish in upper portion.

Litmus milk: Alkaline, congulated Blood serum not hquefied

Acid from glucose.

Aerobie, facultative. Optimum temperature 20°C. Habitat: Disease of caterpillars

15 Pseudomonas boreopolis Gray and

15 Pseudomona's boreopolis Gray and Thornton (Gray and Thornton, Cent. f. Bakt., II Abt , 73, 1928, 74.) From Greek, boreas, the North wind; polis, city; M. L. North City.

Rods: 0.5 to 1.0 by 2.0 to 3.0 microns.

occurring singly and in pairs. Motile with one to five polar flagella. Gramnegative.

Gelatin colonies: Liquefied.

Gelatin stab: Liquefied. Medium reddened.

Agar colonies: Circular or amoeboid, white to buff, flat to convex, smooth, glistening, translucent border.

Agar slant: Filiform, whitish, raised, smooth, glistening, fluorescent.

Broth: Turbid.

Nitrates reduced to nitrites. Starch not hydrolyzed.

Acid produced from glucose.

Attacks naphthalene. Acrobic, facultativo.

Optimum temperature 20° to 25°C. Habitat: Soil.

16. Pseudomonas smaragdina Migula. (Bacillus smaragdinus foetidus Reiman, Inaug. Dissertation, Würzburg. 1887; Migula, Syst. d. Bakt., 2, 1900, 890.) From Greek, smaragdinas, green like the smaragdus, the emerald.

Small rods, occurring singly. Nonmotile. Gmm-negative.

Gelatin colonies: Small, convex, irregular, whitish with greenish shimmer.

Gelatin stab: Slight surface growth. Infundibulturm liquefaction. The liquefied medium becomes light emerald green in color.

Agar colonies · Small, brownish-yellow,

Agar slant. Abundant growth with greenish fluorescence.

Broth: Turbid.

Litmus milk: Not coagulated.

Potato: Dark brown, becoming chocolate brown.

Indole not formed.

Nitrates not reduced.

The cultures give off an odor resembling pasmine.

Aerobic, facultative.

Through dodder, Cuscula competers Ymneker (CONVOLVULACEAE), without infecting this plant vector. Not through pollen from diseased plants. Not through seeds from diseased tobaccog, seed transmission has been reported in the case of recently ripened seeds from diseased tomato.

Serological relationships. Pre-upitin test gives cross reactions between all known attrains, except those characterized by failure to spread systemically in to-bacc. No cross reactions with other viruses except weakly with encurbitmonal curus (Marmor astrictum). Type and other strains of tobacco-mosaic virus give cross reactions in complement-fixation and neutralization test.

Immunological relationships: Plant protection tests, particularly in Nections sylvestris Spegus and Comes, have demonstrated that tissues invaded by any strain of this virus are immune to subsequent infection by the tomate auculamentar train of tolacco-mosaic virus, indirecting a group relationship not shared by other viruses, such as cocumbernorae virus or tolacco magnetic fragrent virus.

Thermal mactivation At 88 to 93° C in 10 minutes, at 86 to 92° C in 30 minutes Filterability Tokacco mosaic views

Filterability Tobacco morate virus was the first virus shown to be filterable, by Iwanowski in 1892, its filterability was confirmed and interpreted by Beijerinek in 1893

Other properties. The ultimate particles of tobacco morate virus have been shown to be rod-shaped and testrome. sometimes associated in pairs, and to end Under proper conditions, thread like paracrystals are formed Specific gravity has been determined as about 1.37, refractive index as about I C. I-scheime mount between all 3.2 and 3.5 Surren arms in media of liner refrictive indices show amountropy of flow. Sedimentation corstants, at 20° C, 187 × 10-11 cm per see per date at infinite dilution for unaccreeated virus and 215 × 10-11 cm per sec. per dyne for associated particles The computed average length of the virus unit is about 272 millimicrons; diameter. 13.8 millirojerons. Electron micrographs show that characteristic particles are rodlike, between 10 and 20 millimicrons in width, variable in length, but in some preparations averaging 270 millimicrons in length for single units, 405 to 540 millimicrons in length for associated pairs: X-ray measurements in air-dry gel show width 15 20 ± 0 05 millimicrons. Solutions stronger than about 1 3 per cent senarate into layers, the lower spontaneously doubly refracting and more concentrated than the upper. At concentrations of electrolytes somewhat less than are required to precipitate the virus as fibres or needle-shaped paracrystals, the solutions form clear gels that become fluid on shaking or diluting (at pll 7 and 30° C). The virus is destroyed by high-frequency sound radiation, by pressures between 6000 and 8000 kilograms per square centimeter, and by hydrogen-ion concentrations above pli II or below pli 1. It is relatively stable between pll 2 and pH 8 It is rapidly broken down in 6 M urea solutions, in the presence of salts, to low-molecular-weight components devoided activity. Analysis of parafied virus earlion 47 7 per cent, hydrogen 7.35 per cent, nitrogen 15 9 per cent, sulfur 0.21 per cent, phosphorus 0.60 per cent, levid 0 0 per cent, carbola drate 1.6 to 2 Oper cent A revised estimate of the sulfur content is 0.20 per cent, probably all in eysterne, no methionine his been detected in the typical variety of this virus The percentages of the following substances in the virus are tyrosine 3.9. trantophane 1.5, proline 4 6, arginine 9 0. phenylalanine 60, serme 64, threonine 5.3, eysteine 0 68, alanine 2 4, aspartic acid 26, glutamic acid 5.3, leucine 64, value 39, nucleic acid 5.8, and amide nitrogen 19, collectively accounting for alout & per cent of the total weight. Yarus formation ceases in infected Lost tissues impersed in 8 0002 molar sodium example edution, beginning easin after removal of evalude.

Literature: The literature dealing with tobacco-mosaic virus is too voluminous to permit citation of more than a few representative publications. Allard, U. S. Dept. Agr., Bull. 40, 1914; Bawden and Pirie, Proc. Roy. Soc. London, Ser. B., 125, 1937, 274-320; Beale, Jour. Exp. Med , 54, 1931, 463-473; Beijerinck, Verhandel. Konink. Akad. Wetenschappen te Amsterdam, II, 6, 1898, 3-22; Grant. Phytopath., 24, 1934, 311-336; Hoggan, Jour. Agr. Res., 49, 1934, 1135-1142; Iwanowski, Bull. Acad. Imp. Sci. St. Petersburg, Ser. 4, 5, 1892, 67-70; Jensen. Phytopath., 23, 1933, 964-974; Johnson, Science, 64, 1926, 219; Kausche et al., Naturwiss., 27, 1939, 292-299; Knight, Jour. Biol. Chem., 147, 1913, 663-666; Kunkel, Phytopath , £4, 1934, 437-466; Lauffer, Jour. Am. Chem. Soc., 66, 1944. 1183-1104, Price, Phytopath., 25, 1933, 749-769; Stnnley, Phytopath., 26, 1936, 305-320; Takahashi and Rawlins, Proc. See Exp Biol. and Med , 50, 1932, 155-157; Vnlleau and Johnson, Kentucky Agr. Exp. Sta , Bull. 376, 1937; Vinson, Science, 66, 1927, 357-358, Woods, Science, 91, 1040, 205-296

Stmins: A great number of variant strains have been isolated both experimentally and from plants infected in nature. These usually share with the type variety most of the fundamental properties, particle size, especially width, stability at relatively high temperatures, long-evity in storage, some common antigens. The following have been distinguished from the type, var. vulgare H. (foc. cit. 17), by varietal nances:

1a. Marmor tabacs var ouesiba H. (foc. cit., 20). A group of isolates producing mecrotic local lesions in inoculated leaves of Nicotiana spleestris Spegaz. and Comes; useful in identifying many other strains of this virus which on prior application protect the tissues of this plant from the nerotic effects of aucuba-type strains (Smith, Ann. Appl. Biol., 18, 1931, 471-493; Kunkel, Phytopath., 24, 1934, 437-466).

1b. Marmor tabaci var. deformans H. (Ioc. cit., 22). Producing exceptionally severe malformation of tomato foliage. (Ainsworth, Ann. Appl. Biol., 24, 1937, 515-550).

ic. Marmor tabaci var. canadense H. (loc. cit., 23). Producing a necrotic type of streak disease in tomatoes (Jarrett, Ann. Appl. Biol., 17, 1930, 218-259).

1d. Marmor tabaci var. lethale II. (loc. ctt., 22). Producing spreading necrotic lessions in tobacco and formato under experimental conditions (Jensen, Phytopath., 27, 1937, 00-84; Norval, Phytopath 83, 1938, 675-6921.

le. Marmor tabaci var. planlaginis H. (Phytopath., 31, 1911, 1937). Specially adapted in nature for systemic spread in species of Planlago. This variety contains histidine (0.55 per cent) and methionine (2 per cent) not found in the type of the species.

11. Marmor tabacı var. obscurum H. (Handb. Phytopath. Viruses, 1939, 25). Systemic in tobacco without producing obvious disease under experimental conditions (Holmes, Phytopath., 24, 193, 845-873, 26, 1936, 890-904; Jensen, Phytopath., 27, 1937, 69-84).

ig Marmor tabacs var. immobile H. (loc. cit, 28). Produces chicotic primary lesions in experimentally infected tohacco, but rarely becomes systemic. (Jeusen, Phytopath., 28, 1933, 964-977; 27, 1937, 69-84).

1h. Marmor tabaci var. arium H. (loc cit., 27) Necrotic lesions experimentally induced in Nicolians glutinesa L. (SOLANACEAE) are much smaller than those of the type variety (Jensen, Phytopath., 27, 1937, 69-81).

 Marmor tabaci var. siccans Doohttle and Beecher. (Phytopath., 32, 1942, 991). Causing necrosis and shriveling of tomato foliage.

McKinney 2. Marmor constans (Jour. Washington Acad Sci., 34, 1911, 326.) From Latin constant, fixed. Common name. Tolacco mild dark-

green mosaic virus

Hosta: SOLANACEAE-Nicotiona glauca R. Grah., tree tobacco

Insusceptible species. SOLANA-CEAE-Lucopersicon esculentum Mill . CUCURBITACEAE-

Cucumis satitus I.., eucumber Geographical distribution: Islands of Grand Canary and Teneriffe

Induced discase In Nicotiana glauca, systemic chlorotic mottling Transmission By inoculation of ex-

pressed juice No insect vector is t word Thermal mactivation. At about 86°C

29, 1030, 200-200

in 10 minutes Literature McKinney, Jour Res 39, 1929, 557-578, Am Bot . 28, 1911, 770-778, Peterson and McKinney, Phytopath., 28, 1938, 329-312. Thornberry and Mckinney, ibid.

Marmor extrictum Holmes (Holmes, Handb Phytopath Viruses, 1939, 27: Musseum astrictum Vallegu. l'hytomath , 50, 1910, 823 ) From Latin astrictus, limited, in reference to host caner

Common names: Cucurbit-mossic virus. English cucumber mosaie virus

Hests CUCURRITACEAL-Cucumix saligus I., eucumber, C anguria I., cherkin, C melo L , melon , Curullus rulsures Schrad , watermelon; only cucurbitaccous plants have appeared to be succeptable thus far.

Insusceptible species. All tested solallaccor's species CUCURBITA-CI IF-lirconia diosca Le: Cucurbita pero l., segriable marrow, LEGU-MINOSAE-Plateclus releares L. var Golden Cluster

Geograp' leal distribution | Legland Induced discree In cucumber clearite of stire and crumpling in young leaves, followed by a green meanir metaling, with

blistering and distortion of newly formed Plant stunted. Fruit unmarked or slightly mottled. Diseased plants less obviously affected during winter months.

Transmission - By inoculation of expresent juice. No insect vector is known.

Serological relationships: Weak cross precipitin reactions and full cross-neutralization reactions with tobacco mosaic virus (Marmor tabaci). Two common antigens postulated Preparations of virue that have been mactivated by treatment with introus seid or X-rays are still anticenic.

Thermal Inactivation . At 80 to 90° C in

10 minutes.

Filterability: Passes Pasteur-Cham. berland filters La to La, and membranes of 150 millimicrons average poro diameter. Other properties: Virus, infectious in dilution of 1014, is present to the extent of 02 to 03 gram per liter of julee from diseased plants. Preparations show sheen and anisotropy of flow, indicating rod-shaped particles Solutions stronger than 2.5 per cent separate into 2 layers at room temperature, the lower being the more concentrated and birefringent. Precipitates with ammonium sulfate show needle-shaped paracrystals Sedimentation constants Sp = 173 × 10-11 cm sec " dyne" and about 200 × 10" em. see .. dyne-t. Virus withstands drying without inactivation but with partial loss of stabity to show anisotropy of flow and with reduction of serological activity to about half Tryptoplane content 1.4 per cent, plenylahanne 10.2 per cent. the first lower and the second higher than in tolerco-mosaic virus.

Literature: Amsworth, Ann. Appl. Hiel . Fr. 1935, Mr. 67 , Bawden and Pine. Nature, 139, 1937, 516-517; Brit, Jour Exp. Path., 18, 1937, 275-291; Knight. Arch Virust , 2, 1912, 264-257; Knight and Stabley, Jour. Biol. Chem , 141, 1911. 29-28, 141, 1941, 29-49; Price, Am. Jour, B. t., 27, 1919, 239-511; Price and Wye. Inff. Nature, 141, 1938, 685.

Strains: A distinctive strain has been distinguished from the type, var. chlorogenus H. (loc. cit., 27), by the varietal name:

3a. Marmor astrictum var. aucuba H. (loc. cit., 29). Differing from the type of this species by inducing a yellow-mottiing, rather than a green-mottling, mocaic in cucumber (Ainsworth, Ann. Appl. Bool., 22, 1935, 55-67).

 Marmor lassiofacters Zaumeyer and Harter. (Jour. Agr. Res., 67, 1943, 305.)
 From Latin lassio, substantive from laedere, to injure, and participle from facere, to make.

Common name: Bean-mosaic virus 4; southern bean mosaic virus 1.

Hosts: LEGUMINOSAE—Phaseolus vulgaris L., bean. Experimentally, also Phaseolus functus L., sieva bean; Soja maz Piper var. Virginia, Virginia soy bean.

Insusceptible species: All tested species in families other than the LEGU-MINOSAE.

Geographical distribution: United States (Louisiana).

Induced disease: In bean, systemic chlorotic mottling in some varieties, localized necrosis in others; in a few varieties, systemic necrosis In mottling-type varieties, chlorotic mottling of foliage; pods marked by dark green blotches or shiny areas, slightly malformed, short, frequently curled at end. In necrotic-type varieties with localized response, bearing a dominant gene lacking in mottling-type varieties, reddish necrotic lesions at the site of inoculation: no evidence of systemic spread of virus. In varieties showing systemic necrosis, pinpoint or slightly larger necrotic primary lesions with veinal necrosis of inoculated leaf; systemic veinal necrosis, distortion and curling of affected leaves, drooping at the pulving, stem and petiole streak; eventual death of plant.

Transmission: By inoculation of expressed juice. Through seeds from infected plants. Serological relationships: Not demonstrated.

Immunological relationships: Previous infection with bean-mosaic virus, Marmor phaseoli, does not protect against infection with this virus.

Thermal inactivation: At 90 to 95° C, time not stated, probably 10 minutes.

Other properties: Withstands dilution

to......, 34, 1944, 510-512; Jour. Agr. Res., 67, 1943, 295-309, 305-328.

Strains: A strain differing from the type has been given the varietal name:

4a. Marmor laessofaciens var. minus Zaumeyer and Harter. (Jour. Agr. Res., 67, 1943, 305.) From Latin minor, lessen. Differing from the type by inducing formation of elightly less diffuse and spreading lesions in necrotic-type bean leaves; also by inducing milder early symptoms and more severe late symptoms in mottling-type beans. Passes through

5. Marmor lethale H. (loc. cil, 80).

us.

na tabacum L., tobacco, A. y. .. langedorffii Weinm.; Lycopersicon esculenium Mill., tomato; Solanum nigrum L. COMPOSITAE -Aster. GERANI-ACEAE-Pelargonium hortorum Bailey. LEGUMINOSAE -- Phaseolus vulgaris L., bean. Confined to roots of these natural hosts except in the cases of Nicotrana tabacum and N. glutinosa in which lower leaves are sometimes invaded; necrotic fesions along midnb and larger veins in these. No obvious manifestations of disease in infected roots. Experimentally to plants in many families with production of localized necrotic lesions only.

Geographical distribution: England, Scotland, Australia. This virus has been found only in greenhouses.

Induced disease: In tobacco, necrosis of midrib and larger veins of first-developed pair of leaves, between November and February. Virus also in roots of many healthy-looking plants throughout the year. Upon artificial inoculation of loliage, numerous small brown necrotic local leasons are produced. Vield of virus from infected plant 0 02 mg per ee of expressed juice, on the average.

Transmission, By contamination of soil with virus. No insect vector is known. Experimentally, by inoculation of expressed juice.

Serological reactions: Precipitates with homologous antiserum. No cross reaction with tomato bushy stunt or tobacco-

morale viruses.

Immunological relationships: Protection tests show lack of relationship to tolurco-moonic sirus, tobacco-ringspot virus, tomato-ringspot virus, eucumbermoonic virus, and the severe-etch strain of tolacco-etch virus.

Thermal inactivation: At 90 to 92° C in 10 minutes.

Filterability: Average particle dismeter 20 to 30 millimerons as determined by filtration through Gradocol membranes; other reports give diameter as 13 to 20 millimerons by filtration (14 to 19 millimierons by radiation experiments, about 20 millimicrons from electron microerabia).

Other preperties: Infections after storage for months in diried leaves and after storage for half a year in alsolute ethal aboved at room temperature. Specific gravity 1.3. More soluble in anumonium sulfate solutions at 0°C than at room temperature. Compestion, Carlon 418, 1645.3 per cert, hittopen 15.5 to 16.5 per cert, hydoren 6.5 to 7.0 per cent, ploasin 1.4 to 1.7 per cent, sulfur 1.1 to 20 per cent, carbob draft 7.0 to 90 per cent, and 5.5 to 7.0 per cent (3 to 5.5 to 7.0 per cent (3 to 5.5 to 7.0 per cent (3 to 5.5 per cent after polyoged dislypic at plt 3). Nuclea and clatter those type last lesson.

isolated. No anisotropy of flow in solution but crystals are birefringent, showing sharp extinctions parallel to, and at right angles to, the plane of the crystal shen examined edge-on in a polarizing microscope. Sedimentation constant, S<sub>2</sub>" = 112 × 10<sup>-11</sup>; in other preparations a crystalline component with sedimentation constant 130 × 10<sup>-11</sup> and an amorphous component with sedimentation constant 53 × 10<sup>-12</sup> have been reported, as well as small amounts of a substance with sedimentation constant 220 × 10<sup>-13</sup>.

Strains: Isolates of tobacco-necrosisvirus serologically distinct but not otherwise different from each other appear to imply the existence of several strains of this virus, or of a closely related group of

viruses, in England.

Literature: Fawden, Brit. Jour. Exp. Path., 22, 1911, 59-70; Bawden et al., bid., 23, 1912, 314-328; Cohen, Proc. Soc. Exp. Bod. and Med., 43, 1911, 103-167; Lea, Nature, 145, 1910, 137-138; Price al., Parasitol., 59, 1933, 513-531; Price, Am. Jour. Bot., 25, 1938, 603-612; Arm. Jour. Bot., 27, 1910, 530-511; Arch. Virust., 4, 1910, 530-581; Arch. Virust., 4, 1910, 530-581; Price and Wyckoff, Phytopath., 29, 1939, 83-91; Smith, Parasitol., 29, 1937, 70-85; 29, 1937, 50-68; Smith and Badl, Parasitol., 27, 1935, 234-215; Smith and MacClement, Parasitol., 32, 1910, 300-332

5a. Marmor dodershedron H. (loc.cit, 30). From Greek didekahedron, it sleenhedron

Common name. Tomato bushy-stunt

Hosts SOLANACEAE—Lycoperation esculentum Mill, tomato Experimentally, alon SOLANACEAE—Datura giramonium I.; N. Ionamonium I.; LEGU. WIAOSAE—Placeolar najuum I. LEGU. WIAOSAE—Placeolar rulginii, I. Jean, Tigoa siuomiii (I.) Lodil, compra. COMPOSITAE—Zinnia diegons Jacq., inmia

Geographical distribution: British

Induced disease: In tomato, some primary lesions necrotic, ring-like or spot-like, others masked, or disclosed only by chlorophyll retention in yellowing leaves. In young plants, systemic necrotic lesions may cause death; in older plants, growth ccases, young leaves become pale yellow; growing points may die. inducing growth of oxillary buds to produce a bushy top; older leaves become rellowed and show some purple coloration. In White Burley tobacco, local necrosis only, lesions small, red at first. . then white. In cowrea, reddish necrotic primary lesions only.

Transmission: By inoculation of expressed juice. Through dodder, Cuscuta compestris Yuncker (CONVOLVULA-CEAE). Not through seeds of diseased plants. No insect vector is known.

Serological relationships: A specific antiserum, prepared by a single intravenous injection of rabbits with 2 mg of purified virus, gives granular, compact precipitates, serving for quantitative estimation of this virus, antiserum being used at dilutions of 1:200 or 1:800, virus at dilutions to 10-6.

Immunological relationships. Will infeet plants previously invaded by tobacco-mosaic virus, tomato spotted-wilt virus, tobacco-ringspot virus, and Bergerac-ringspot virus.

Filterability: Passes membranes down to 40 milhmicrons average pore diameter Other properties: Virus crystallizes

from solutions of ammonium sulfate as isotropic, rhombic dodecahedra, which shrink and swell reversibly on drying and rewetting; shrinkage reduces size to 80 per cent of the wet dimensions. In the presence of heparin, non-birefringent prisms, rather than dodecahedra, appear. Sze\* = 132 × 10-11 cm. sec.-1 dvne-1. Particle approximately spherical, 27A millimicrons in diameter by X-ray measurements (average diameter by filtration data, 14 to 20 millimierons). Solutions do not show anisotropy of flow. Inactivated by drying. Molecular weight Density 1.353. Molecular 8,800,000. weight may be as high as 21,000,000 in solution, but the density is then lower, 1.286. Analysis : carbon 47 to 50 per cent, nitrogen 15.8 to 16.4 per cent, phosphorus 1.3 to 1.5 per cent, ash 1.7 to 5 per cent, hydrogen 7.2 to 82 per cent, suffur 04 to 0.8 per cent, carbohydrate 5 to 6 per cent.

Literature: Ainsworth, Jour. Ministry Agr., 45, 1936, 266-269 : Bawden and Pirie, Nature, 141, 1938, 513; Brit. Jour. Esp. Path., 19, 1938, 251-263; Bernal and Fankuchen, Jour. Gen. Physiol., 25, 1911, 111-165, Bernal et al., Nature, 142, 1938, 1075; Cohen, Jour. Biol. Chem. 144, 1912, 353-362; Proc. Soc. Exp. Biol. and Med , 51, 1942, 194-195; Lauffer, Jour. Phys. Chem., 44, 1040, 1137-1146; Lauffer and Stanley, Jour. Biol. Chem., 155, 1940, 463-472; Neurath and Cooper, Jour. Biol. Chem., 135, 1940, 455-462; Smith, Nature, 155, 1935, 908; Ann. Appl. Biol , 22, 1935, 731-741; Jour. Roy. Hort. Soc., 60, 1935, 448-451; Smith and MacClement, Parasitol., 55, 1941, 320-330; Stanley, Jour. Biol. Chem., 185, 1940, 437-454.

Key to the species of the Tobacco-Etch Virus Group.

Viruses saletyply susceptible to heat inactivation (inactivated at 52 to 58° C in 10 minutes)

1. . of the group in tobacco.

other, if

group; dominant member

6 Marmor crodens.

II. Replaced by No. 6, not by No. 8, if in mixture with it in tobacco.

III. Replaced by No. 6 or 7 if in mixture with either in tobacco.

 Marmor erodens Holmes. (Holmes, Handh. Phytopath. Viruses, 1839, 40; Foliopellis erodens Valleau, Phytopath., 20, 1910, 825) From Latin erodere, to erode or gnaw anay.

Common name: Tobacco-etch virus Hosts: SOL.1 NACEAE—Copercum frutescens I.., pepper; Datura stramonium I., Jimson weed; Lycoperaicon seculentum Mill., tomato, Nicotiana tabacum I., toincco, Petunia sp., petunia; Physalis heterophylid Necs

Geographical distribution: United States.

Induced disease: In tobaco, systems unld-mottling chlorosis, with traces of necrotic etching; attranuclear crystalline tochisons and intracytophasmic granular and morphous inclusions that tend to crystaliue, forming needle-shaped birthingent bother, 2 to 10 microns in length

Transmission: Experimentally, by Myzus persione (Sulz), M. erretumfezus (Buckt), Aphis rhamin Boyer, A fabae (Sop.), and Macrosiphum gei (Kocli) (APHIDIDAE), by inoculation of ex-

presed juice. Semigeral relationships: Precipition rections with homologous antisers, but no cross-reactions will foliacco-mesae virus, tolacco-mesae virus, potato-mid mesaic virus, potato-mid mesaic virus, potato-mid mesaic virus, potato-embanding virus, potato-embanding virus, or ten mosaic virus.

Immunological relationships: Protects to leave a grants unbecapient infection by postate venilating a size and hypocyamis mosaic virus. In mixed infections, at suppresses and replaces these two viruses.

Thermal inactivation At \$140.55° C in

10 minutes

Litterdulity Passes Pasteur Chamberland la, not la, filter candle

Other properties. Sedimentation constant Set = 170 × 10.12 cm sec. (dynest, Concentrated proporations show anisatrapy of flow, in heating chargated particle state.

Laterature Randemand Kassania, Ann

Appl. Biol., 28, 1941, 107-118; Fernow, Cornell Agr. Exp. Sta. (Ithaca), Mem. 96, 1925; Holmes, Phytopath, 32, 1942, 1058-1067; Johnson, Kentucky Agr. Exp. Sta. Res. Bull. 306, 1930.

Strains: A distinctive severe-symptom strain, isolated from plants infected in nature and studied intensively, has been distinguished from the type, var. *vulgare* II. (loc. cit., 40), by the varietal name:

63 Marmor erodens var. sererum II. (loc cut., 41) Differing from the type by a tendency to induce more pronounced necrotic etching and a greater stunting effect in infected tobacco.

Marmor hyoscyami spec. nor.
 From New Latin Hyoscyamus, genus name of plant from which this virus was first isolated

Common names: Hyoseyamus-mosaie virus, Hy. III virus, Hyoseyamus-IIIdisease virus.

disease virus.

Hosts: SOLANACEAE—Hyoscyamus
niger L., henhane Experimentally, also

Nicotiana tabacum I., tobacco.
Insusceptible species .CUCURBIT.t.
CEAE—Cucumis satirus I., cucumber.

Geographical distribution, lingland, Induced disease, In benkane, chlorotic cleaning of veins followed by yellow-mot-

thing mound

Transmission By inoculation of expressed juice to dilutions of 10%. By aphads, Ugicus persion (Sulz.), W circumfexus (Buckt.), and Macrotiphum solanifolis Ashin. (\*\* W ges Koch) (APHEPIDLE).

Serological relationships. Several 1800htes of this varus give mutual errorsprecipitin reactions but no precipitation occurs when antiserium prepared with this varus is mixed with enumber mosale varus, tobacco-etch varus, or potato veinhambure varus.

Immunological relationships: No immunity with respect to the across in duced in tolerco by previous infection with enumber resource views. Potato-vendending virus is unable to multiply in the presence of this virus and is replaced by it. Telecoverth virus proplaced by it. Telecoverth virus pro-

tects against this virus and replaces it in mixed infections.

Thermal inactivation: At 58° C in 10 minutes.

Filterability: Passes Chamberland La, but not La, filter candles.

Other properties: Concentrated solutions show anisotropy of flow. Yield of virus, 1 to 3 mg per liter of juice expressed from diseased tobacco plants.

Literature : Bawden and Kassanis, Ann. Appl. Biol., 28, 1911, 107-118; Hamilton, bid., 19, 1932, 550-507; Sheffield, ibid., 25, 1933, 781-789, Watson and Roberts, Proc Roy Soc London, Ser. B, 127, 1939, 513-576.

8. Marmor upsilon comb nos. (Marmor cucumers var. upsilon Holmès, toc. ct., 33; Muraiba rendaenta Valleau, Phytopath., 30, 1910, 821.) From Greek name of the letter Y, sometimes used to denote this virus

Common names. Potato-veinbanding virus, potato virus Y

Hosta: SOLANACEAE—Solanum tuberosum L., pointo, Nicotiana tabacum L., tohacco Experimentally, also Lycium barbarum L.

Geographical distribution: England, France, United States, Brazil. Rare in Scotland and part of Ireland

Induced disease In some potato varieties, leaf drop and necrotic stem-streak; in others, no signs of disease; in still others, chlorotic mottling with or without necrosis. In combination with strains of the potato-mottle virus (Marmor dubium), this virus causes rugose mosaic, a common and destructive double-virus disease. Transmission: By inoculation of expressed juice. By aphid, Myrus persicus (Sulz.); experimentally, also by Aphis rhamni Boyer (synonym for Aphis abbrenata Patch) (APHIDIDAE).

Serological relationships: Preipitin reactions with homologous antisers. No cross reactions with tobacco-mosaic vrus, tobacco-etch virus, hyoseyamus-mosaic virus, potato-mottle virus, potato mildmosaic virus, potato aucuba-mosaic virus, tobacco-ringspot virus, or common peamosaic virus. Reported cross reaction with cucumber-mosaic virus needs confirmation.

Immunological relationships: A mild strain protects against subsequent affection with the typical virus. This virus is suppressed and replaced by hyoseyamus-mosaic virus and by tobacco-etch virus in mixed infections.

Thermal inactivation: At 52° C in 10

Filterability: Passes with difficulty through Gradocol membrane of 42 millimicron average pore diameter.

Other properties: Inactivated by dry-

ng.
Literature: Dennis, Nature, 14, 1938,
154; Johnson, Phytopath., £5, 1933,
650-652; Jones and Vincent, Jour. Agr.
Res. 55, 1937, 68-79; Kasanis, Ana
Appl. Biol., 29, 1912, 95; Koch. Phytopath., £5, 1933, 310-342; Kramer and Sifberschmidt, Arquivos Inst. Riol., SöPaulo, Brazil, 11, 1940, 165-188, Salman,
Nature, £59, 1937, £924; Smith, Proc. Roy
Soc., Scr. B., 109, 1931, 251-267; Smithard
Dennis, Ann. Appl. Biol., £7, 1940, 65-70

Key to the species of the Cucumber-Mosaic Virus Group.

Viruses relatively susceptible to heat inactivation, requiring less than 10 minutes at 85 to 90° C for complete inactivation. Not replacing potato-veinbanding virus in mixed infections

- I. Infecting both dicotyledonous and monocotyledonous plants.

  9 Marmar cucumerts
- II. Infecting dreatyledonous, but not monocotyledonous, plants
  - 10. Marmor solani. 11. Marmor aucuba.
  - 12. Marmor umbelliferarum.

- 13. Marmor cruciferarum.
  - 14. Marmor brassicae
  - 15. Marmor belac.
  - 15. Marmor lactucae.
  - 18. Marmor phaseals.
  - 19. Marmor leguminosatum.
  - 20. Marmor pisi
  - 21. Marmor medicaginis.
- III. Infecting monocotyledonous, but not dicotyledonous, plants.
  - 22. Marmor tulipae.
  - 23. Marmor mile.
  - 21. Marmar sesdis.
  - 25. Marmor eaechari.
  - 26. Marmor cepae
- 9. Marmor cucumeria Holmes circumflexus (Buckt.)
- (Holmes, Handb. Phytopath. Viruses, 1939, 31; Murialba cucumeris Valleau, Phytopath, 50, 1910, 823.) From Latin cucumis, encumber.
- Common name. Cucumber-mosaic virus
- Hosts Very wide range of hosts among diectyledonous and monocotyledonous plants, eucumber, telery, spinaels, to bacco, and prepier are sometimes seriously affected Overwintering hosts are, SOLANACHAR—Physics subglatrata Mackenia and Bush, P. heterophylla Nees ASCLEPIADACEAR—Astepna syrt aca L. PHYTOLACCACLE—Physics aca L. PHYTOLACCACLE—Physics aca L. PHYTOLACCACLE—Physics can decander L. LABIATAE—Nepta celara L. Puralshly there are also other susceptible personals.
- Geographical distribution: Probably at most world wide
- Indiaced disease. In encumber, Cucurus satura L., sellowish green systeme
  motting leaves small, discorted,
  curled, planta twarfed, interrosters shortened Ten Irust set. Truits mottled,
  mathapen, gaving the disease the name
  "whate pickle." In black con-per, Virgasuccess (d. ) Irust, and irredush necrotic leval lessons only. No intracellular
  ledies are found in planta infected with
  cucumber me de virus.
- Transmission By incondition of expressed juice. By aphilis, Mysus persicae (Fulz.), M. pseudosciani Theob., M.

circumferns (Bucks.), Marcauphum solomofot Ashim, and Aphis govepin Glov. (APHIDIDAE). Through seeds of discased plants in Echinocystis Iobate (Niclax.) Torr and Gray, wild cucumber, in Cucumiu melo Li, mushnelon, and in Cocurbita perpo Li, vegetable marrow. By several species of dodder, Cuscula catifornica Choisy, C. cempestra Yuncker, and C. subinclusa Dur and Hille (CONVOLVULGLE)

- Immunological relationships, Infection with the type and other ethicatio-motiting strains protects rinnin against subsequent infection by an indicator attain of this virus (var judicis)
- Thermal mactivation At 70 to 80° C
- Filterability: Press Berkefeld W and N filters and collodion membranes of 45 millimetron average pure diameter
- Other preperties. Inactivated by drying or 3 to 4 days' storage in juice at room temperature.
- Literature Answorth, Ann Appl. Bod. 25, 1938, 875-870, Chamberlain, New Zedand Jour Science and Technology, 21, 1979, 734-904, Celmo, Philippine Agr. 22, 1990, 379-444, Dodittle, Phytopath. 6, 1916, 115-447; U.S. Dept. Agr. Bull 879, 1929, Dodittle and Walter, Jour. Agr. Res. 51, 1925, 1-5-5; Gilbert, Phytopath. 6, 1916, 113-411, H. gran, Jour. Agr. Res. 47, 1923, 569-701, Jazer, Phytopath. 6, 1916, 143-415.

8, 1918, 32-33; Kendrick, Phytopath., 24, 1934, 820-823; Mahoney, Proc. Am. Soc. Hort. Sci., 532, 1935, 477-480; Price, Phytopath., 25, 1935, 776-789; 29, 1939, 903-905; Am. Jour. Bot., 27, 1940, 530-641; Storey, Ann. Appl. Biol., 26, 1939, 298-308.

Strains: Various bost plants seem to have induced specialization of enumber-mosaic virus in strains particularly adapted to existence in their tissues. Several of these and certain laboratory-derived strains useful in technical procedures have been distinguished from the type, var. vulgare H. (loc. cit., 31), by varietal names, as follows:

9a. Marmor cucumers var. commelinae H. (doc. cit., 35). From New Latin Commelina, generio name of weed errying as a natural reservoir of this strain. Common name: Southern celery-mosaic strain of cucumber-mosaic virus. Differing from the type in sevently of disease induced in celery and some other plants. Transmitted by Aphis gossypti Glov., A. maidis Fitch, and Pentalonia myomerosa Coq. (APHIDIDAE). (Prec. Phytopath, 25, 1035, 947-954; Wellman, tbid., 24, 1934, 695-725, 1032-1037, 28, 1935, 293-208, 377-404.)

9b Marmor cucumeris var. phaseoli Hoc cit, 38b. From New Latun Phaseolius, generie designation of lima bean. Common oame: Lima-bean strato of cucumber-mosaie virus Differing from type of species in ability to cause a chlorotic mottling disease in lima bean in nature. (Harter, Phytopath., 26, 1936, 94, Jour. Agr. Res., 56, 1938, 855-906, McClintock, Phytopath, 7, 1917, 60.)

9c. Marmor eucumeris var. Islii H. (locct, 37). From Latin Itium, lily. Common name: Lily-mosae strain of eucumber-mosaic virus Differing from the type variety by ability to persist in nature in lilies, producing masked infection or chlorotic mottling unless in mixture with lily-symptomless virus (Adclonesus Ibli), wheo a more severe disease involving necrosis is induced. (Brierley, Phytopath, 22, 1393, 3; 50, 1940, 230-237, Brierley and Boolittle, tbid., 50, 1910, 171-174; Ogilvie and Guterman, tbid., 18, 1929, 311-315; Price, tbid., 27, 1937, 561-560.)

9d. Marmor cucumeris var. judicus II. Roc. cit., 33). From Latin judez, judec. Common name: Indicator strain of cucumber-mosaic virus. Differing from the type variety in inducing the formation of necrotic local lesions in zinai. (Zinnia etegans Jacq., COMPOSITAE). Previous infection of zinais by other strains of cucumber-mosaic virus inhibits the formation of these necrotic local lesions, identifying the strains sa rolated to each other and to the indicator strain. (Price, Phytopath, 22, 1931, 743-761, 28, 1935, 776-780.

9e, Marmor cucumers var. rignae II. (loc. cit., 39). From New Iatin Vigna, generie name of cowpea. Common mose: Cowpea-mottling stmin of cucumbermosaic virus. Differing from the type wariety in producing systemic chloroite mottling, rather than reddish-brown necrotic local leasons, in Black coapes Not known in nature but derived experimentally from a mild-mottling strain of ucumber-mosaic virus during serial passage in cowpea. (Price, Phytopath 24, 1934, 749-741; 28, 1935, 776-787)

 Marmor solani H (loc. cit, 47).
 From New Latin Solanum, generic name of rotato.

Common names: Potato mild-mo-aic

virus, potato virus A.

Hosts: SOLANACEAE—Solanum tuberosum L., potato. Experimentally, also Nicotiona tabacum L., tobacco; Solanum nigrum L. var. nodifforum; and Datura stramonium L., Jimson need.

Geographical distribution: United States, England, Holland.

Induced disease: In potato, very mild chlorotte mottling or masked symptoms to some varieties (as Irish Chieftain), systemic necrosis in others (for example, Optimum temperature 37°C.

Subcutancous and intravenous moculations into rabbits cause death in 36 to 48 hours

Source: Isolated from nasal secretions in orena.

17. Pseudomouss chlorina (Frankland and Frankland) Levine and Soppekand (Bacillus chlorinus G. and P. Frankland, Philos. Trans. Roy. Soc. London, 178, 1887, 274; Bacterium chlorinum Migula, Syst. d. Rokt., 2, 1909, 471, Levine and Soppekand, Bul. No. 77, Iona State Agricultural College, 1926) From Greck, rhloros. greenish yellow

Rods: 0.5 by 1.5 micron, occurring singly and in short chains. Non-motile. Gramnegative.

Gelatin stab. Crateriform liquelaction with green fluorescence. Lemon yellow sediment.

Agar colonies: Circular, raised, amooth, amorphous, entire, becoming greenish yellow.

Agar slant Slightly raised, glistening, the medium becoming light greensh vellow.

Broth Moderate turbidity Dirty yellow sediment No pellicle

Litmus milk: Peptonized Litmus reduced.

Potato: Scant, olive green growth

Indole formed. Nitrites produced from nstrates

Starch hydrolyzed. Blood serum hquefied in 5 days

Acid from glucose Aerobic, facultative Optimum temperature 22°C Source: Air.

cource: Air.

18. Pseudomonas ofeovorans Lee and Chandler. (Jour Bact., 41, 1911, 378.) From M. L. oil destroying

Short rods, 0.5 by 0.5 to 1.5 micross, occurring singly and in poirs. Matile Gram-negative

Gelatin stale: No liquefaction after 6 weeks.

Gelatin colonies: Up to 1 mm in diameter, fluorescent, similar to agar colonies,

Surface agar colonies: After 24 hours 1 to 2 mm. in diameter, smooth, convex, shuy, opaque, creamy, fluorescent by transmitted light Edge entire in young colonies.

Deep agar colonies: 0 5 by 1 0 to 1 5 mm, lens-shaped, buff-colored, not flu-

Agar slant Growth raised, smooth, fluorescent, edge erose

Broth After 21 hours moderate turbidity with slight yellowish viscid sediment. No pellicle or ring.

Latmus milk. No change

Indole not formed Potato: Good growth

Nitrites are produced from nitrates

Starch is hydrolyzed No acid from glucose, lactose, sucrose, galactose, sylose, mannitol, solicin and

galactore, tylore, mannitol, solicin and glycerol

Loughly good growth at 25° and 37°C.

Distinctive character The fluorescent quality of the colonies is not imparted to any of the artificial media used. Source Isolated from cutting com-

Source issued from energy compound (oil-water emulsion) circulating in a machine shop. The oil in this compound may be utilized as a sole source of energy

Halant Probably oil scaked soils.

19 Pacudomonas incognita Chester (Bacillus fluorescens incognitus Wright, Memours Nat. Acad. Sci. 7, 1995, 436, Chester, Determinative Bacteriology, 1908–233; From Latin, in, not, copilo, to think, M. L. unknown.

Short rods, with rounded ends, occurring single, in pairs and in chains. Motile, possessing a polar flagellum. Gram-

negative
Gelvin observe Thin, transporent,
slightly principles, becoming greensh
Marrin undulate. The medium assumes

a lilge green fla vrecence

1937, 903-912; Dykstra, Phytopath., 29, 1939, 917-933.)

12. Marmor umbelliferarum II. (loc. cit., 67). From New Latin Umbelliferae, family name of plants among which celery is classified.

Common name: Celery-mosaic virus, western celery-mosaic virus.

Hosts: UMBELLIFERAE—Apium gravolens L., celery and celeriae; Daucus corola L., carrot. Experimentally, also Anchum gravolens L., dill; Anthriscus cerefolium (L.) Hollm., salad chervii; Carım carrı L., caraway; Coriondrum satteum L., coriander; Petroselinum hordense Hollm, narslev.

Insusceptible species: Gueumis satirus L., eucumber, and all other tested species not of the family Umbelliferae.

Geographical distribution: United States (California).

Induced disease In celery, at first, clearing of veins in young leaves; later, foliage yellowed, pl.nt stunted, young petioles shortened older petioles horizontal, giving plant a flat appearance. Foliage mottled green and yellow; leaflest marrow, twisted or cupped; older feaves with some necrosis; petioles with white streaks or spots. In celeriac, clearing of veins, followed by systemic chlorotic mottling. In carrot, chlorotic spotting of young leaves, followed by systemic chlorotic chlorotic mottling.

Transmission · By moculation of expressed juice, in dilutions to 1:4000. No specific insect vector is known, but 11 species of aphids capable of breeding on celery transmit the virus, though they do not long retain the power of transmission after leaving diseased plants These vectors are Aphis apigrareolens Essig. A apii Theob , A. ferruginea-striata Essig, A. gossypsi Glov , A. middletonss Thomas, A rumicis Linn, Caroriella cap-Muzus circumflexus (Fabr.), (Buckt.), M. contolvuls (Kalt ), M. persicae (Sulz.), Rhopalosiphum melliferum (APHIDIDAE) (Hottes)

aphids not able to breed on celery also transmit this virus.

Thermal inactivation: At 55 to 60° C in 10 minutes.

Filterability: Passes all grades of Chamberland filters.

Other properties: Virus active after storage at -18° C for 18 months.

Literature: Severin and Freitag, Hilgardia, 11, 1938, 493-553.

 Marmor cruciferarum H. (loc cit., 69). From New Latin Cruciferae, family name of plants among which cauliflower is classified

Common name: Cauliflower-mossic

Hosts: CRUCIFERAE-Brussica olerocea L., cauliflower, kale, Brussels sprouts, cabbage, and broccoli; B. campestris I., wild yellow mustard; Matthiola incana R. Br., annual stock. Experimentally, also Brassica adpressa Boiss; B. olba Rabenh., white mustard, B. arrensis (L.) Kize., charlock; B. juncea Coss., leaf mustard fone strain not susceptible); B. napus L., rape; B. petsai Bailey, pe-tsai; B. nigra Koch, black mustard; B. rapa I., turnip; Capsella bursa-pastoris Mcdic., shenberd's purse; Iberis amara L , rocket candytuft; Lepv dium saticum L., garden cress, Lunaria annua L., honesty; Raphanus raphanistrum L., white charlock; R sainus L,

radish. Insusceptible species: CHENOPODI-ACEAE-Spinacia oleracea L. COM-POSITAE-Lactuca sativa L. CRUCI-FERAE-Alussum saratile I.; A. marifimum Lam.; Arabis albida Stev; Athysanus pusillus Greene; Brassics juncea Coss. (Japanese strain; another strain susceptible); Cherranthus cherri L., Erysimum perofskianum Fisch and Mey.; Hesperis matronalis I.; Malcomia marifima R. Br.; Roripa nasturtium Rusby; Stanleya pinnala (Pursh.) Britt.; Thysanocarpus radians Benth. LEGU-MINOSAE—I reia faba L. SOLANA. CEAE-Capsicum frutescens L.; LycoperIlutish Queen). Immunity to sphid infection with this virus is found in the varieties Katahdin and Earlaine. A combination disease, characterised by pronounced yellow-measic patterns, is caused by this virus in the variety Irish Clucitain if the potato-veinbanding virus (Marmor upulon) is also present. In tolacco, experimentally, faint veinbanding measic.

Transmission: To potato, by rubbing incthods of inoculation of expressed juice, using carborundum powder; to tobacco, by rubbing without carborundum. By aphilds, Aphis abbrevata Patch and Mysus persoace (Sulz ) (APHIDIDAE)

Serological relationships: No crossprecipitin reactions with potato aucubamonair vitus, potato-eichbanding vitus, toliacco-mosaic virus, toliacco-etch virus, tableco-ringspot virus, or pea mosaic virus.

Immunological relationships. A feeble strum of this virus has been found to pratect fully against the typical strain in the Netherlands

Thermal Inactivation: At 50° C in 16 minutes.

Iatenture Banden, Ann. Appl. Biol. 52, 1935, 187-197; Chester, Phytopath,
 193, 193-197; Chester, Phytopath,
 193, 1933, 686-701, Dykstra, Phytopath,
 193, 193-197, 193-198; Murphy and Loughane,
 193, 193-199, Murphy and McKay,
 193, 193-199, Murphy and McKay,
 194, 194-199, Murphy and McKay,
 194, 194, 197, 237-247; Ourtaijn Botyes,
 Tujeker, Plantennickten,
 193, 25-29,
 194, 194, 194, 194-29,
 195, 194, 194, 194-29,
 196, 194, 194, 194-29,

If Marmor aucuba If (for cit, 49) from New Latin Accuba, a genus of plants bavong mottled foliage.

Common name. Potato auculo merare

Hous SOLANAURAE—Solation to terrown L. potato. Diperimentally, also Attopa. Golladiana. L. (ayingtandera), Captición frotaccas. L., pepper, Datara stranonium L., Jimon weed. (symptom. less). Hyperpanies. niger. L., Lenlane. (symptomless); Lycopersicon esculentum Mill., tomato; Petunia hybrida Vilm., pelunia (symptomless); Nicotiana tabacum L., tobacco (symptomless); Solanum dulcamara I., bittersweet; S. nigrum L. var. nodiforum.

Geographical distribution: Unite States, Great Britain, Europe.

Induced disease: In potato, yellow spots on lower leaves of some varieties; in the variety Irish Chieftain, brilliant yellow mottle over whole plant, perhaps because of simultaneous presence of potato mid-measic virus in this variety. Necrosis of the cortex and of the pith in tubers in many varieties.

Transmission: By inoculation of expressed juice Probably by aphid, My-

Serological relationships: No precipitin cross-reactions with potato mild-mosale virus, potato-veinbanding virus, tobacco-mosale virus, tobacco-etch virus, tobacco-trus-pot virus, or pea-mosale virus. Precipitin cross-reactions with the Canada-streak strain of potato aucuba-mosale virus.

Thermal inschwation: At 65 to 68° C in 10 minutes,

l'ilterability: Passes Pasteur-Chamberland la filter, but not La or La.

Laterature. Chester, Phytografts, 25, 1933, 654-701; 27, 1937, 905-912; Clinchi, Sci. Proc. 103. Dublin Soc., 22, 1941, 193-115, Clinch et al.; 1944, 221, 1936, 431-418; Dipletra, Phytograft, 29, 1939, 913-933.

Strains: One strain differing from the type has been given a varietal name:

Ha Marmor aucuba var. canadense Black and Price (Phytopath, 30, 1910, 111) From common name of strain.

Common name: Canada streak strain of potato autula mesue virus. Differing from the type variety by tendency to produce necrosic instens, yena, petiolea, and feaves and also, about 2 months after Larvest, in pith of tuler, especially at stem end. (Clester, Phytogath, 27.

under identical circumstances. More work is needed to show existing alliances.

Literature: Chamberlain, New Zealand Jour. Agr., 53, 1936, 321–330; New Zealand Jour. Science and Technology, 21, 1939, 212A–223A; Clayton, Jour. Agr. Res., 40, 1930, 263–270; Gardner and Kendrick, ibid., 22, 1921, 1923–1921; Hoggan and Johnson, Phytopath., 26, 1935, 610–614; Larson and Walker, Jour. Agr. Res., 26, 1933, 307–392; 62, 1941, 475–301; Schultz, Jour. Agr. Res., 22, 1921, 173–178; Smith, Ann. Appl. Biol., 22, 1935, 203–212; Tompkins, Jour. Agr. Res., 67, 1938, 559–602; 68, 1939, 63–77; Tompkins et al., ibid., 67, 1938, 203–943.

15. Marmor betae H. (loc. cit., 72). From Latin beta, bect.

Common name: Sugar-beet mosaie

Hosts: CHENOPODIACEAE—Beta vulgaris I., beet; Spinacia olcracea I., spinach.

Geographical distribution: France, Denmark, Germany, Sueden, United States, England.

Induced disease: In beet, discrete yellorish secondary lesions or clearing of veins on young leaves, followed by chlorotte mottling of newly formed leaves. Darkening of vascular tissue. Leaves bend back near tips, which sometimes die. Intracellular bodies formed. In spinach, 0 to 21 days after infection, chlorottic feeks on young leaves. Plant stunted, outer leaves killed, dying from their tips back. Center of plant survives for time, but finally dies.

Transmission By inoculation of expressed juice, in dilutions to 10<sup>-2</sup>. By aphids, Myzus persuca (Sult.), Aphis rumtes Linn., and perhaps Macrostphum solanifolis Ashm. (= M. get Koch) (APHIDIDAE). No seed transmission.

Thermal inactivation: At 55 to 60° C in 10 minutes.

Other properties: Inactivated by standing in expressed juice for 24 to 48 hours at about 70° F. Literature: Böning, Forsch. Geb. Pflanzenkr. u. Immun. Pflanzenteich, 3, 1927 81-123; Cent. f. Bakt., 11 Abb., 71, 1927 490-497; Gratia and Manil, Compt. rend Soc. Biol., Paris, 118, 1935, 379-38; Hoggan, Phytopatl., 23, 1933, 446-441; Jones, Washington Agr. Exp Sta Bull. 259, 1931; Lind, Tidsskr. Planteavl, 22, 1915, 444-457; Robbins, Phytopath, 11, 1915, 444-457; Robbins, Phytopath, 12, 1924, 1949, 19

16. Marmor lactucae H. (loc. cit., 81). From Latin lactuca, lettuce.

Common name: Lettuce-mosaic vius. Hosts: COMPOSITAE—Lactuce a-tira 1., lettuce; Senecio vulgaris 1., groundsel. Experimentally, also COMPOSITAE—Sonchus asper Hofm, prickly sow-thistic. LEGUMINOSAE—Lathyrus odoratus 1., sweet pea; Pisum sativum 1... nea.

Insusceptible species; COMPOSITAE

-Sonchus oleraceus L, S. arrensis L,
Taraxacum officinale Web., Carduus arrensis Curt. CRUCIFERAE-Bras-

stramonium L.

Geographical distribution: United States, England, Germany, Bermuda.

Induced disease. In lettuce varieties, clearing of veins followed by systemic chlorotic mottling, dwarfing and defective hearting, sometimes by scorching of leaf edges, venn necrosis or necrotic flecking between veins.

Transmission: By inoculation of expressed juice, in dilutions to 1:100 it mixed with a little 0.5 per cent solution subplute solution and a trace of pondered carborundum. By aphidis, Mysus persicae (Sulr.), and Macrosuphum ger Koch (APHIDIDAE). Through seeds from diseased plants It is believed that seedborne vurus is the most important source of primary incombum in the spring.

Thermal inactivation: At 55 to 60° C

in 10 minutes.

sicon esculentum Mill.; L. pimpinellyfoltium Mill.; Nicotiana glutinose L.; N.
langsdorfii Weinm.; N. labacum L. van.
Turkish and White Burley. TROPAEOLACEAE—Tropacolum majus L.
UMBELLIFERAE—Apium graveolens L.

Geographical distribution United States, England.

Induced disease: In cauliflower, clearing of veins, followed by mild chlorotic
mottling, veins usually banded with dark
green, necrotic flecks later in chlorotic
areas. Midro eurvel, lexuse distorted,
Plant stunted; terminal head or curd
dwarfed. Folanaccous plants appear to
be immune, a point of distinction between
this virus and turnip-movaic virus, Marmor brusiness.

Transmission: By inoculation of experiend pilec, using carborundum powder. By many aphid species, Breveroryne braviese (Linn), cabbage aphid; Rhopaloniyhhim pseudobrasisea Divis, Iabse cablage aphid; Al gusu persicae (Soliz), pacha phidi; Johie gracolens Essig, celery leaf aphid; A. apigracolens Essig, celery aphid, A. middlednii Thomas, erigerom root aphidi; A gossypis Glov, cotton aphid; Carariella caprae (Fabr ), yellaw willow aphid, Myzus circumferus (liuck), Iliyapidi; Rhopalonipham mellferum (liottes), boncysuckle aphid (APHIDDIAD). No seed transmission

Thermal inactivation: At 75° C in 10 minutes.

Laterature Caldwell and Prentice, Ann. Appl. Biol., 23, 1912, 306-373, 374-379, Riswlins and Tompkins, Phytopath., 24, 1934, 1147 (Alat.); Tompkins, Jour-Age Res., 25, 1937, 33-46

14. Marmor brassicae II (II., loc. est., 70. Marmor matthiolie II., loc. est., 71.) I mm New Latin, Brassica, generic rame of turnip

Cor mon rame. Turnip inexale virus

| Hora | CHUCIPULAE - Prairica

raps L., turnip, B. rapolenistica Mill.,

sweede or rutaloga; B. napus L., rape; B.

acea L. cabbage; Armoracia rusticana Gaertn., horse-radish; Cheiranthus cheiri L. wallflower: Matthiola incana R. Br., stock: Sinapis alba L., white mustard. Experimentally, also CRUCIFERAE-Berteroa incana (L.) DC : Brassica alba Rabenh., white mustard; B. arrensis (L.) Kize.; B. chinensis L., Chinese cabbage; B. juncea (I.) Coss.; Capsella bursa-pastoris (L) Medic.; Cardamine heterophylla (Forst. f ) O. E. Schultz: Cherranthus allionii Hort ; Coronopus didumus Smith: Hesperis matronalis L : Lenidium ruderale L . L. satirum L . L. ttrainteum L : Nasturtium officinale R. Br : Neslia paniculata (L.) Desv : Radicula palustris (L.) Moench : Raphanus saficus I.; Sisymbrium allissimum I.; S officinale (L ) Scop : Thiasps arrense CHENOPODIACEAE-Bela vulcaris L.: Spinacia oleracea L. spinach.

nima (I.) Koch, black mustard; B. oler.

gorti I.; Spinaci cettare II; spinaci COMPOSITAE—Calendula officinalis I.
Zinnia elegans Jacq RANUNCULA
CEAE—Delphinium apacit I. SOLANACEAE—Lycopersicon pimpinellyfolium
Mill , Nicotiana bipelorii B Wati; N
giulinosa I., N langadoffi Welnim , N
repanda Willd , N. ruutica I.; N. sylecitris Spec, and Comes; N. tabacum I.,
toloeco, Petunia hybrida Vilm

Geographical distribution United States, England, New Zealand

Induced disease In turnip, systemic chlorotic mottling; plants stanted, leaves

distorted In tolacco, experimentally, characteristic necrotic primary lesions only

Transmission Be inoculation of ex-

presed juse Hy cablege aphid, Breedergne brassicae (binn), and by the peach aphid, Myrus persicae (Sult.) (APHIDIDAE)

Thermal inactivation: At 54° C in 10 minutes

Strains A considerable number of strains of this virus appear to occur in nature, but those that have been studied eften have been considered as distinct viruses and not compared with each other

ally, also Cicer arietinum L.; Desmadium canadense (L.) DC.; Lathyrus sativus L., grass pen; Lupinus albus L., white lupine: L. angustifolius, blue lupine; L. densiflorus Bentli.; L. hartwegii Lindi.; L. nanus Dougl.; Medicago arabica Huds., spotted bur clover; M. hispida Gaertn., oothed bur clover; Melilotus alba Desr., white sweet clover; M. indica All., annual yellow sweet clover; M. oficinalis (L.) Lam., yellow sweet clover; Phaseofus acutifolius Gray, tepary bean; P. vulgaris L., bean; Trifolium agrarium L.; T. caralinianum Michx.; T. dubium Sibth.; T. glomeratum L , cluster clover: T. hybridum L., alsike clover: T. incarnatum L., crimson clover; T. procumbens L.; T. reflexum L.; T. suaveolens, Persian clover; Vicia sativa L., common vetch.

Insusceptible species: All tested species in families other than the Leguminosac.

Geographical distribution: United States, British Isles, Europe, New Zealand.

Induced disease: In pea, clearing of veins in young leaves, followed by chlorosis of newly formed leaves, stunting of plant, and systemic chlorotic mottling. In sweet pea, systemic chlorosis and chlorotic mottling, flower colors broken In lupine, necrotic streak on one side of stem, stunting of plant and bending of growing point to injured side. Plant soon wilts and dies. In Vicia faba, motted leaves contain characteristic isometric crystals in host-cell nuclei (especially within nucleoli) as well as in cell cytoplasm

Transmission By inoculation of expressed juice, with ease. By asphids, Macrossphum pies Kalt., M. solanijolii Ashm (= M. ge: Koch), and Aphis rumicis Linn (APHIDIDAE). Not transmitted through seed.

Serological relationships: Specific precipitin reactions differentiate this virus from tobacco-mosaic virus, tobacco-etch virus, potato-mottle virus, potato mildmosaic virus, potato aucuba-mosaic virus, and tobacco-ringspot virus Thermal inactivation: At 60° C in 10 minutes.

Literature: Chester, Phytopath, 25, 1935, 688-701; Doolittle and Jones, 10sd, 15, 1925, 763-772; Johnson and Jones, Jour. Agr. Res., 64, 1937, 629-638; McWhorter, Phytopath., 51, 1941, 760-761; Marphy and Pierce, 4bid., 27, 1937, 1829-603; Pierce, Jour. Agr. Res., 64, 1935, 1017-1037; Spiercaburg, Tijdschr. Plantenz., 47, 1930, 71-76; Zaumeyer and Wade, Jour. Agr. Res., 51, 1936, 161-161.

Marmor plst H. (loc. cit, 90).
 From Latin pisum, pea.

Common name: Pea enation-mosaic virus.

Hosts: LEGUMINOSAE—Pisum sativum L., pea; Vicia faba L. broad bean Experimentally, also Lathyrus odoratus L., sweet pea; Soja max (L.) Piper, soy bean; Trifolium incarnalum L., crimson clover.

Insusceptible species: LEGUMINOSAE—Arachis hypograc II., peanut,
Medicago saita I., alfalfa Melilous aldo
Desr., white sweet clover; M. officinalis
(I.) Lam., yellow sweet clover; Phasenlus aureus Roth, mung boan P. vulgaris
I., bean; Trifolium hybridum I., alsike
clover; T. pratense I., red clover; T.
repens I., white Dutch clover. SOiANACEAE—Lycopersicon exculentum
Mill., tomato; Solanum tuberosum I.,
potato.

Geographical distribution: United States, perhaps Germany.

Induced disease: In peas, systemic chlorotic mottling; in some varieties, as Alderman, occasional necrotic spots and numerous enations on lower surfaces of leaves. Pods distorted. In broad beam, systemic chlorotic spotting and stripics of leaves. In sweet pea and soy bean, experimentally, systemic chlorotic mottling.

Transmission: By inaculation of expressed juice, using carborundum; more readily from aphid-inoculated plants than from mechanically-inoculated plants Filterability: Fails to pass L. Pasteur-Chamberland filter.

Literature: Ainsworth and Ogilvie, Ann Appl Biol., 26, 1939, 279-297; Jagger, Jour. Agr. Res., 20, 1921, 737-740; Newhall, Phytopath., 13, 1923, 104-106.

 Marmor dahliae II. (loc cif, 85).
 From New Latin Dahlia, generic name of host plant.

Common name: Dablia-mosaie virus.

Hosts: COMPOSITAE—Dahlia pinnata Cav, iluliia. Experimentally, also
D imperialis Hogal.; D. mazonii Safford.

Geographical distribution: United States, Holland, Germany, England

Induced disease in intolerant varieties of dahla, chiorotic nottling of lolage, leaf disturtion, dwarfing of all stems and of roots, occasionally necrotic streaking of midseins. In lolerant varieties, inconspicuous chiorotic mottling or masked symptoms.

Transmission. By aphid, Myzus persicae (Sulz.) (APHIDIDAE). By gratuing Not by inoculation of expressed juice Not through soil. Not through social from diseased plants.

Laterature Brierley, Am. Dahlia Soc. Bull , Ser 9, No 65, 1931; Contrib Boyce Thompson Inst. 5, 1933, 235-288; Goldstein, Bull Torrey Bot. Club, 54, 1927, 285-271

15 Marmor phaseoli II (loc. cit, 87) From New Latin Phaseolus, generic name of lean

Common rame. Bean movate virus. Hosts. LLGU VI SOSAR—Plareolus religiris L. Jean. Experimentally, also Phareolus acutifolius Gray was datyfolius. Freem. P. aureus Roch., P. coloratus. Roch., P. binatus. L., Lespodera strong (Thunb ) Hook, and Arn., Viera faba. L., P. sajara. L., panga yetch.

Insusceptible species Lt GUMINO-SAF - Prison rationer L., garden pes, Lattyres obratus L., sweet pes Geographical datubation World wide,

ul efeser leans are grown. Induced docum: In lean, first leases to be affected are crinkled, stiff, chlorolie; later leaves show chlorotic mottling; leaf margins often rolled down. Optimum temperature for expression of discase, 20 to 25° C, partial masking at 28 to 22° C, complete masking at 12 to 18° C.

Transmission: By inoculation of expressed twice in dilutions to 1:1003, using carborundum or other abrasive powder. By aphids, Aphis rumicis Linn., Macroarphum (= Illinoia) solanifolii Ashm. M. pisi Kalt., Aphis gossypii Glov., A. medicaninis Koch, A. spiraccola, Brevicorune brassicae (Linn.), Hyalopterus atriplicis Linn., Macrosiphum ambrosiae Thos. Rhopolosiphum pseudobrassicae Davis, and My:us persione (Sulz.) (APHIDIDAE). In beans, there is seed Iransmission to 30 to 50 per cept of plants emwn from infected parents; pollen from infected plants is said to transmit virus.

Thermal inactivation. At 56 to 55° C in 16 minutes.

Lateralure. l'ajardo, l'hytopath.. 20. 1930, 469-191, 883-888; Murphy, thid., 30, 1910, 779-781; Murphy and Pierce, ibid . 28, 1938, 270-273; Parker, Jour. Agr Res , \$2, 1936, 895-915; Pierce, Phytomth., 24, 1931, 87-115, Jour. Agr. Res., 49, 1931, 183-188; 61, 1935, 1017-1039; Reddick, II Congr. Intern. Path Comp., 1931, 363-366; Reddick and Stewart. Phytorath , 8, 1918, 530-531; Richards and Burkholder, Phytopath., 53, 1943. 1215-1216; Wade and Andres, Jour Agr. Res . 63, 1911, 359-373; Warle and Zaumeyer, U.S. Dept. Agr., Circ. 500, 1938; Walker and Johnstte, Phytomath., 33. 1913, 778-788, Zammeyer and Keatns, abed . 26, 1000, 614-627, Zaumeyer and Wade, Jour Age Hes. \$1, 1935, 715-749.

19 Marmor leguminosarum II. (loc. est., vi) From New Latin Leguminosae, family name of per Correson name: Per mosaic virus.

Heets. LEGUMINOS, IE-Lathyrus odoratus I., sweet pra; Pinun satirum L., pra; Trafohum pratense L., red eksres; Vicia fota I.,, broad brain. Experiment. 446). From New Latin Solanum, generic name of potato.

Common name. Potato-calica strain of alfalfa-mosaic virus. Differing from the type by inducing a more severe disease in potato, in which it is commonly found in nature. (Price and Black, Phytopath., 30, 1940, 414-41; Dykstra, 164d, 29, 1939, 917-933; Porter, Potato Assoc. Amer. Proc., 18, 1931, 65-69; Hilgardia, 6, 1931, 277-294; 9, 1935, 383-394.)

 Marmor tulipae H. (loc. cit., 52).
 From New Latin Tulipa, generic name of tulip.

Common name: Tulip color-adding virus.

Hosts: LILIACEAE-Tulipa generiana L., garden tulip; T. eichleri Regel; T. greigi Regel.

Insusceptible species: AMARYLLI-DACEAE—Narciessus sp., nareissus. IRIDACEAE—Ins germanica L., iris. LILIACEAE—Allium cepa L., onion. SOLANACEAE—Nicolvana labacum L., tobaeco.

Geographical distribution: Wherever hybrid tulips are grown.

Induced disease. In tulip, no obvious effect on leaves but dark striping of flower by pigment intensification. Lattle interference with growth of plant. No intra-collular bodies.

Transmission: By hypodermic injections of expressed juice in dilutions to 10<sup>-8</sup>. By sphiles, Myzus persicae (Sulz ), Macrosrphum solanifoli Ashm. (= M. gei Koch, Illinous solanifoli Ashm.), Aphis (= Anuraphis) tultipae B. de Fonsc. (on bulbs), and perhaps Macrosrphum pelargonn Kait (APHIDDAS), Not through seeds from diseased plants.

Not through seeds from diseased plants.
Thermal mactivation At 65 to 70° C in
10 minutes.

Literature: Hughes, Ann. Appl. Biol., 18, 1931, 16-29; 21, 1934, 112-119, Mr-Whorter, Phytopath., 22, 1932, 998 (Abst.); 25, 1935, 898 (Abst.); Ann. Appl. Biol., 25, 1938, 254-270.

Marmor mlte H. (loc. cit., 53).
 From Latin milis, mild.

Common name: Lily latent-mosaic virus.

Hosts: LILIACE AE—Lalium amabli; L. auratum Lindl.; L. canadense L.; L. candidum L.; L. cernaum; L. chaedadicum L.; L. cerocum Chaix; L. daemottae; L. elegans Thunb.; L. formosamus Blapf.; L. ojiganteum; L. henryi Bsker; L. leucanthum; L. tongiforum Thunb.; L. myriophyllum; L. pumlum; L. repet Wils.; L. sargentiae Wils.; L. specuoum Thunb.; L. superbum L.; L. teslaceum Lindl.; L. tigrinum Ker; L. umbildum Hort.; L. wallacei; Tulipa gesneriana L., garden tulip; T. clustana Vent.; T. limfolia Reccl.

Insusceptible species: LILIACEAE—
Allium cepa L., onion; Lilium kansoni
Leichtl. IRIDACEAE—Iris germanica
L., iris. SOLANACEAE—Nicotana tabacum L., tobacco.

Geographical distribution. Wherever lilies and tulips are cultivated.

Induced disease: In Easter lily, masked symptoms or systemic chlorotte mottling, in either case without necrotic flecking. In tulip, systemic chlorotte mottling in foliage and flower "breaking" (color moval, except in a few varieties in which color intensification occurs instead). In tracellular bodies characterize inwaded tissues.

tissues.

Transmission. By inoculation of expressed juice (rubbing surface of leaves), in both filly and tulip. By plugging and grafting of dormant bulbs of tulip. By aphids, Mysus persence (Sulz.), Macrosphin solamifoliu Aslum. (= M. gri Koch), and Aphis (= Anuraphis) tulipee Koch), and Aphis (= Anuraphis) tulipee B. de Fonso. (APHIDIDAE). Not through seeds from mosaic Latium loopit Rorum.

Thermal inactivation: At 65 to 70° C in 10 minutes.

Literature: Atanasoff, Bull. Soc. Bot. Bulgarie, 2, 1923, 51-60; Brierley, Phytopath., 29, 1939, 3 (Abst.); 50, 1940, 230Infective in dilutions to 10°. By aphida, Macrossphum prist Kait. and M. solantfobrii Ashm. (= M. per Koch) (APHI-DIDAE), with incubation periods of about 12 hours before the insects can infect. Not through seeds from diseased plants

Thermal inactivation: At 66° C in 10 minutes

Literature Büning, Forsch. Geb. Pflanrenkr u Immun Pflanzenreich, 4, 1927, 43-111, Johnson and Jones, Jour. Agr Res. 54, 1937, 622-635; Loring et al., Proc Soc Exp. Biol and Med. 2, 83, 1933, 232-211; Osborn, Phytopath. 25, 1933, 100-177, 28, 1938, 749-751, 923-931, Pierce, Jour Agr Res., 21, 1933, 1077-1039, Snyder, Phytopath., 24, 1931, 78-80; Stubhr. 304, 27, 1937, 212-27, 1937, 1938

21 Marmor medicaginis II (loc est , 01) From New Latin Medicago, generic name of alfalfa (lucerne).

Common name Alfalfa-movaie virus Hosts LEGUMINOSAE-Medicago satua L. alfalfa (Incerne) SOLANA-Cli.11. Solanum luberorum L., potato L'auxumentally, also transmissible to many species of dicetyledonous plants (summarized by Price, Am Jour Bot , 27, 1910, 530 511) including CUCURBI-TACEAE - Cucumis ratirus L. eucum-COMPOSITAE-Zinnia elegina ler Jaca . rinnia LEGUMINOSAE-Phaseolus tolgaris L., bean, Trifolium pregrantum le, etimen clover SOL ANACTAE-Capticum feulescens 1. pepper, Lycoperation esculenture Mill . tomato. Accopana tabacum L. tobacco Geographical distribution

hister

Induced disease. In alfolfa, systemic chimute northing, tending to be masked at innes. In bean, (most varieties) small necessive privary lessons, redden bown at periptery. No secondary besons, bone lean varieties show no besons after insculation, one of these, Belipte Biggo, pressess two direlman grees either ef witch will confer this type of resistance. In believe, white necessite of the deep white necessite of the state of the s

flecks, small rings and arcs on inoculated leaves, later, systemic mottling, followed by production of necrotic oak-leaf patterns; virus content may be low in plants long diseased, especially in summer

Transmission: By inoculation of expressed juice By aphilds, Vaccosiphum pist Ralt. (for typical strain) and M. solangolis Ashm. (for potato-calico strain) (APHIDIDAE) Not through seeds from diseased plants.

Immunological relationships: Resistance to superinfection with the type of this virus is conferred by earlier infection with potato-calico virus (now considered a related strain but earlier regarded as distinct), but not by earlier infection with potato-mottle virus, encumbermosale virus, or the Canada streak strain of potato aueuth-mosale virus.

Thermal inactivation - At 65 to 70° C in 10 minutes

Other properties Sedimentation constant, 739 ± 52 × 10<sup>-11</sup> cm per see, in a unit centrifugal field Specific volume 0 673 Farticles spherical or nearly sa Deumeter 165 millimiterons, weight 21 × 10<sup>6</sup> times hydrogen unit leaderter point about pil 4 6. Inactivated and, more slowly, hydrolyzed by trypus

Literature: Black and Price, Phytopath, 59, 199, 441-417, Ladifer and Bloss, Jour Am Chem Soc. 62, 1910, 329-5-3300, Perce, Phytopath, 24, 1931, 57-115; Price, Am Jour Bot. 57, 1910, 539-531; Ross, Phytopath, 57, 1911, 391-410, 410-420, Wade and Zammeyer, Jour. Am. Soc. Agron. 52, 1910, 127-131, Zaumeyer, Jour Agr. Ros. 6, 1938, 347-712.

Strains At least one strain of alfalfameans virus was formerly considered as an independent virus, causing a disease known as exhici in jotsto. It has now been given strictal rank and dethinguished from the type, var. typicos. Black and Pince (Phytopath., 29, 1910, 466) by the following tame.

21a Marmor medicaj nis var solani Mark and Price (Phytogath, 59, 1910, Other properties: Active after storage 27 days at -6° C.

Literature: Brandes, Jour. Agr. Res., 19, 1920, 131-138, 517-522; 24, 1923, 247-262; Desai, Current Science, 3, 1935, 18; Forbes and Mills, Phytopath., 35, 1913, 713-718; Ingram and Summers, Jour. Agr. Res., 62, 1936, 879-888; Kunkel, Bull. Exp. Sta. Hawaiian Sugar Planters' Assoc., Bot. Ser., 5, 1921, 115-167; Matz., Jour. Agr. Res., 46, 1933, 521-529; Rafay, Indian Jour. Agr. Science 5, 1935, 633-670, Sein, Jour. Dept. Agr. Porta Rico, 14, 1930, 49-68; Stoneberg, U. S. Dept. Agr., Tech. Bull. 10, 1927; Tate and Vandenberg, Jour. Agr. Res., 59, 1939, 73-79.

Marmor cepae H. (loc. cit., 66).
 From Latin cepa, onion.

Common name: Onion yellow-dwarf virus.

Host. LILIACEAE—Allium cepa L., anian (the variety viviparum Metz. is symptomless when infected and may serve as an unrecognized reservoir of virus).

Geographical distribution: United States, Germany, Czecho-Slovakia, Russia, New Zealand.

Induced disease In onion (most varieties), yellow streaks at base of developing leaf, followed by yellowing, crinking, and flattening of newly formed leaves; leaves prostrate, flower statks bent, twisted, stunted; plants reduced in size, bulbs small, yield of seeds reduced. A few varieties of onion are relatively tolerant, and the tree-onion, var. viriparum is symptomics after infection.

Transmission: By inoculation of expressed juice. By 48 of 51 tested species of aphid, principally Aphis rumers Lann, A. mandis Fitch, and Rhopalosuphum Not.

by contaminated soil.

Thermal inactivation. At 75 to 80° C

Other properties: Virus withstands dilution to 10-\*, storage at 29° C for about 100 hours and storage at -14° C for more than time tested (6 hours), but is inactivated by drying in leaf tissues.

Literature: Andreyeff, Rev. Appl. Mycol., 17, 1938, 575-576; Blattny, Ochrana Rostlin, 10, 1930, 130-138; Bremer, Phytopath. Ztschr., 10, 1937, 79-105; Brierley and Smith, Phytopath., 34, 1944, 506-507; Chamberlain and Baylis, New Zealand Jour. Science and Technology, £1, 1939, 229A-236A; Drake et al , Iowa State Coll. Jour. Science, 6, 1932, 317-355; Jour. Econ. Ent., 26, 1933, 841-816; Henderson, Phytopath., 20, 1930, 115 (Abst.); Iowa State Coll. Research Bull. 188, 1935, 211-255; Melhus et al., Phytopath., 19, 1929, 73-77; Porter, U. S. Dept. Agr., Plant Dis. Rept., 12, 1928. 93; Tate, Iowa State Coll. Jour. Science, 14, 1940, 267-294,

27. Marmor scillearum Smith and Brierley (Phytopath., \$4, 1944, 503.) From New Latin Scilleae, name of tribe in which hosts are classed.

Common name: Ornithogalum-mosaic

Hosts: LILIACEAE (of the tribe Scilleae)—Ornithogalum thyroides Jacq.; probably also Galtonia candrans Decne.; Hyacinthus orientalis L., hyacinth; Lachenatus sp.

Insusceptible species: LILIACEAE
(of the tribe Scilleae)—Muscari botty-

DACKAE—Peneralium maritimum, Zephyranthus sp. IRIDACEAD—Tritoma crecta (L.) Ker. LILIACEAF—
Agapanthus africanus, Allium ceps, 
nuon, A. cernuum Roth: A. Astaloum 
L. A. portum L. Glorious orthechildina 
O'Ricen, Lilium formosanum Stapt; and 
L. longiforum. SOLANACEAE—Nicetima telabeatum L.

Geographical distribution: United States (Oregon; probably also Alabams and presumed to be widespread in plants of the squill tribe, Scillege, of the family

LILIACEAE).

Not

237; 5f. 1911, 838-813; Brierley and Booluttle, töd., 50, 1910, 171-174; Cayley, Ann. Appl Biol., 16, 1928, 523-539; 9, 1932, 183-172; Guterman, Hort. Soc. N. Y., Vearb., 1520, 51-102; Ilali, Gard Chron., 65, 1933, 339-331; Hughes, Ann Appl. Bod., 2f, 1931, 112-119; McKay and Warner, Nat. Hort. Mag., 12, 1933, 179-216; McWhorter, Phytopath, 25, 1933, 593 (Abst.); Science, 65, 1937, 179; Ann. Appl Biol., 25, 1938, 251-270, Science, 83, 1938, 411; Ogilvic and Guterman, Phytopath, 19, 1929, 311-315.

24 Marmor tridis II. (loc. est., 55) From New Latin Iris, generic name of tris

Common name : Iris-mosaic virus

Hosts: IRIDACEAE—Iris flyolia Boiss, I. tingitana Boiss, and Reut, and I riphium L., bullousinises; Iris ricardi Hort, I unguicularis Poix; learded iris, variety William Mohr

Insusceptible species: SOLANA-CRAE-Lycoperation esculentum Mill., tomato; Nicoliana tabacum Li, tobacco, Petunia hybrida Vilm, petunia. LILIA-CEAE-Tulipa generiana L., tulip

Geographical distribution United States (Washington, Oregon, California), Hallind, Bulgaria, France, England Induced disease In Bulbous rises,

ilwaring of plant, chieretic mottling of folium, breaking of flowers. Bate of increase in planting stock decreased Hower forcaks usually district than normal color of flower. Vacuolute intracellular ladies in some affected tissues.

Transmission: By injection of freshly extracted jutes of diseased plants into interredial tissue. By aplads, theresphere (\*\* Illinoid) solanifotis Volimand Mysius persions (Sult.) (APHIDI DAE)

Laterature Brierley and McWhorter, Jour Agr Res , 81, 1976, 621-635

25 Marmor aaccharl II (be est , 60) Fran New Latin Succession, princis name of sugar caud, front Latin sac-

Common name: Sugar-cane mosaic

Hosts: GRA WINEAR—Saccharum offeinarum L., sugar cane, Holeus sorghum I., sarghum; H. sudanensis Balley, Sudan grass; Brachiarua platyphylla Nash, Chaetochlon magna Seribun, C. ertetellada Seribu, P. aspalum boscianum Fluegge; Syntherisma angquinale Dulae. Experimentally, also Zea mays L., corn (maire); Chaetochlon lutecens Stuntz; Echmochlon crusgalli Beauv; Mucanthus sunransi Andersa, eubilis; Panicum dicholomiforum Michx, Pennestum glauchua R. Ir., peatl millet; Saccharum anernga Wall.

Insusceptible species: All tested speeics other than Grammeae,

Geographical distribution. Originally in Far Last, now in acarly all countries where sugar cane is grown; believed still to be absent from Mauritius.

Induced disease: In sugar cane, ayateme motiling chlorosis, light areas of pattern eloogated, but crossing venus Occasionally, stem cankers. Regularly, descoleration and necrosis in nature mnestalk tissues. Vacuolate intracellular leades occur in diseased tissues. Canes sometimes recover, spontaneously foring the virus and becoming susceptible to runlection. By inoculation of ex-

pressed junce (puncture through moculum into young leaf). By aphide, Jphie randus litch, Carolinane cyperi Aimlee, Hydroneura sitariae (Thomas), and Teoptera gramium Roud; not by Sipha fara lorbes (APHIDIDAE) Not by Braceslacephala melliper (Say) (CCADELLID II)

berological relational upon Specific neutralizing and precipitating antibodies have been demonstrated

Thermal mactivation At 53 to 51°C in 10 run ites in leaf tipones Gelatin stab: No liquefaction.

Agar slant: Thin, moist, translucent, becoming greenisb.

Broth: Turbid, with pelliele, becoming greenish.

Litmus milk: Slightly acid in a month. The litmus is slawly reduced.

Potata: Moist, glistening, spreading, brown.

Indole is formed (trace).

Nitrites are produced from nitrates. Aerobie, facultative.

Optimum temperature 35°C.

Habitat: Water.

Pseudamonss convexa Chester. (Bacillus fluarescens convexus Wright, Memoirs Nat. Acad. Sci., 7, 1895, 438; Chester, Determinativa Bacteriology, 1901, 325.) Fram Latin, convexus, convax, arched.

Short, thick rads, with rounded ends. Motile, possessing a polar flagellum.

Gram-negative

Gelatin colanies. Circular, convex. glistening, bright greenisb, translucent. The medium becomes blue-green, fluarescent.

Gelatin stab. Light green, raised, glistening surface growth. No liquefac:

Agar slant : Moist, translucent, glisteaing, light greenish. The medium 4ssumes a greenish color

Broth: Turbid, becoming greenish Litmus milk: No coagulation; alkalne.

Potato: Pale brown, spreading.

Indole not formed. Nitrates not produced from nitrates

Aerobic, facultative. Optimum temperature 30°C.

Habitat · Water.

21. Pseudomonas mildenbergii Be gey et al. . Der blaue bacillus, Milder berg, Cent. ma Bakt, II Abt., 56, 192 309; Pseudo y Pas cyanogena Bergey (12. 123; not Bacil Flagge, Die Mikroorgan.

ismen, 1886, 201; not Pseudomonas cyanogenes Hammer, Dairy Bact., 1928, 70; Bergey et al., Manual, 3rd ed., 1930, 172) Named for Mildenberg who first isolated this species.

Rods: 0.3 to 0.5 by 1.0 to 3.5 microns, with rounded ends, occurring singly. Motile, possessing polar flagella. Gramnegative.

Gelatin 'colonies: Circular, lobed, smooth, gjistening, slightly raised, steelblue, entire.

Gelatin stab: Na liquefaction.

Aga J colonies: Small, circular, yellowish or reddisb-yellow, entire, becoming lobe i, grayisb green, iridescent. The medium becomes dirty grayisb-green.

Agar slant: Smooth, spreading, slimy, gl'stening, grayish-green ta dark green,

fl Jorescent.

Broth: Turbid green, iridescent to pralescent with slimy sediment. Litmus milk: Nat congulated, blus

ring. Potato: Slimy, glistening, spreading,

steel blue. Indale not formed.

Nitrites not produced from nitrates. Aerobic, facultative.

Optimum temperature 25°C. Source: Isolated from air.

2. Pseudomonas putida (Trevisan) Miguls. (Bacillus fluorescens putidus Flügge, Die Mikroorganismen, 2 Aufl, 1886, 288; Bacillus putidus Trevisan, I gen. e le specie d. Batteriacec, 1889, 18; Migula, in Engler and Prantl, Die natur. Pflanzenfam., 1, 1a, 1895, 29; Bacillus fluorescens putridus (sic) Kruse, in Flugge, Die Mikroorganismen, 2, 1896, 292; Bacterium putidum Lehmarn and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 271; Pseudomonas putrida (sic) Migula, Syst. d. Bakt., 2, 1900, 912.) It is not clear which spelling should be used. Either is correct. From Latin putida or putrida, rotten, stinking.

Rods, with rounded ends. Motile,

Induced disease: In Ornithogalum thyrsorder, young leaves finely mottled with light and dark green, and becoming more conspicuously mottled with gray or yellow as the leaves mature; flower stalks sometimes boildly marked with light and dark green blotches In perianth segments, thin longitudinal streaks Transmission: By inoculation of expressed juice in the presence of fine carborandum ponder, with difficulty. By aphids, Aphis possypit Glov., Macrosiphum Ithi Monell, M. solanifolii Ashm., and Myzus persicae (Sul.2.); less efficiently by Myzus circumflexus (Buckt ) (APHIDIDAE).

## Key to the species of the Miscellaneous Mosaic-Virus Graup.

Many of the following viruses, although described in some detail in the literature, stand in need of reinvestigation to determine additional properties and possible relationships to preceding groups.

- I. Affecting species of MALVACEAE.
- 23. Marmor abutilon.
  11. Affecting species of CELASTRACEAE
- 29. Marmor euonymi.
- III Affecting species of OLEACEAE
- 30 Marmor ligustri.
- IV. Affecting species of LEGUMINOSAE (and no. 39, other families also).
  - 31. Marmor scourns.
  - SZ. Brurnur arac
  - 33 Marmor trifolii. 34. Marmor pachurhizi.
  - 35. Marmor vimae
  - 36. Marmor repens.
  - 37. Marmor fastidiens.
  - 38. Marmar iners
  - 39. Marmor efficiens.
  - V Affecting species of GRAMINEAE
    - 40. Marmar tretier.
  - 41. Marmar grammas.
    VI. Affecting species of MUSACEAE.
  - 42 Marmor abaca
- VII Affecting species of PASSIFLORACEAE

  43 Marmor passiflorae.
- VIII. Affecting species of ROSACEAE.
  - 44. Marmor flaccumfaciens.
  - 45. Marmor rosae.

    46. Marmor veneniferum.
  - 40. Altimor cenentje
  - 47. Mormor mali.
    48. Marmor fragariae
  - 49. Marmor marginans.
  - 50. Marmor margina
  - 51. Marmor persicae.
  - 52. Marmor astri.
  - 53. Marmor rubicinosum.
  - 51. Marmor cerasi.
  - 55. Marmor lineopictum. 56. Marmor pallidolimbatus.
  - 57. Marmor nervictorens.

- IX. Affecting species of VITACEAE.
  - 58. Marmor viticola.
  - X. Affecting species of SANTALACEAE.
- Affecting species of CONVOLVULACEAE and, experimentally, of other families.
  - 60. Marmor secretum,
- XII. Affecting species of GERANIACEAE.
  61. Marmor pelargonii.
- XIII. Affecting species of SOLANACEAE and in most cases also of other families.
  - 62. Marmor angliae.
  - 63. Marmor aevi. 64. Marmor raphani.
- XIV. Affecting species of PRIMULACEAE.
  - 65. Marmor primulae.
- XV. Affecting species of MORACEAE,
  66. Marmor caricae,
  - XVI. Affecting species of RUTACEAE.

    67. Marmor italicum.

28. Marmor abutilon H. (loc. cit., 50). From New Latin Abutilon, generic name of a host.

Common name: Abutilon-mosaic virus Hosts: MALVACEAE-Abutilon striatum Dicks. var. thompsonii Veitch. Experimentally, also Abuttlon arboreum Sweet; A. avicennae Gaertn.; A. esculentum St. Hil.; A. indicum Sweet; A. ineigne Planch.; A. megapotamicum St. IIII. and Naud , A. regnellis Mig ; A. sellowianum Regel, A. venosum Lem ; A. vitifolium Prest.; Alihaea ficifolia Cav.; A. officinalis L ; A. rosea Cav.; Anoda hastata Cav ; Kitaibelia vitifolia Willd ; Malva borealis; M crispa; M, mauritiana Mill.; M. sylvestris L ; M. verticillata L ; Malvastrum capense Garcke; Modiola decumbens G. Don ; Sida mollis Herb ; S. napaea Cav.; Sidalcea candida A. Grav.

Insusceptible species: MALVACEAE
—Althaea taurinensis; Sidalcea purpurea;
Sphaeralcea umbellata G. Don.

Geographical distribution: Germany, France, England, United States; ong. inally obtained from a single vanegated seedling found among green plants of Abution stratum imported from the West Indies in 1868 by Veitch and Sons; subsequently the infected plant \*\*132i\*

propagated vegetatively as an ornamental variety.

Induced disease: In Abution, systemic chlorotic mottling. Recovery occurs it there is presistent removal of affected leaves, suggesting that the virus does not increase in stems. After recovery, plants are susceptible to reinfection.

Transmission: By grafting, except patch-bark-grafting, which is ineffective Occasionally through seeds from diseased plants. Not by inoculation of expressed purce. No insect vector is known

Varieties: Distinctive strains have been noted, but not separately named; one isolate originally occurring in Abuliton darsini var. teasclatum, seems to belong here; it differs from the type principally in severity of induced discuss and in ability to infect Landera arbora

in anity to linear Zaturia and Sol.

Literature: Raur, Ber. d. Deutsch Rot.

Geselbsch. 22, 1901, 453-460; 24, 1906,
416-428; 25, 1907, 410-418; K. Preuskad. Wiss., Sitzungsber., 1906, 11-19;

Davis, Ann. Missouri Bot. Gard., 16,
1929, 145-226; Hertzsch. Ztechr. I. Bot.,
29, 1927, 65-85; Keur, Phytopath., 23,
1933, 29 (Abst.); 24, 1934, 12-13 (Abst.);

Bull. Torrey Bot. Club., 61, 1936, 52-76;

Landemath, Cartenflora, 51, 1902, 333-

29. Marmor euonymi H (loc. cst, 51). From New Latin Euonymus, generic name of host.

Common name: Euonymus-mosaic

virus

Hosts · CELASTRACEAE—Euonymus japonica L f (sometimes written Econymus japonicus) Probably also E radicana Sieb.

Geographical distribution; Germany.
Induced disease In Euonymus 10001-

ica, persistent yellowing along veins

Transmission. By grafting.

Literature Baur, Ber. d. Deutsch Bot. Gesclisch, 26a, 1908, 711-713, Rischkon, Biol Zentralbl, 47, 1927, 752-764

30 Marmor ligustri H (loc. cit., 52) From New Latin Ligustrum, generic name of host, from Latin Ligustrum, ancient name of privet plant.

Common name. Ligustrum-mosaic

VITUS

Host OLUACEAE-Liquitrum vul-

gare L., common privet
Geographical distribution. Germany
Induced disease Systemic chlorotic

spotting Transmission By grafting Not

through seeds from discased plants.
Literature. Baur, Ber. d. Deutsch
Bot Gesellsch, 25, 1907, 410-413

31 Marmor laburni H. (loc. crt., 51). From generic name of a host plant, Laburnum vulgare

Common name Laburnum-mosaie

Hosts LEGUMINOSAE-Laburnum vulgare Griseb. (= L anagyroides Medic), bean tree. Experimentally, also

Cytisus hirsutus L.
Insusceptible species. LEGUMINO-SAE-Laburnum alpinum Griseb., Cytisus vurpureus.

Geographical distribution Germany Induced disease. Systemic chlorotic variegation.

Transmission: By bark grafts or by

budding. Not through seeds from diseased plants of Laburnum vulcare.

Literature: Baur, Ber. d Deutsch. Bot. Gesellsch., 25, 1907, 410-413

32 Marmor arachidis H. (loc cit., 67) From New Latin Arachis, generic name of peanut

Common name. Peanut-rosette virus
Host. LEGUMINOSAE-Arachis hu-

poguea L., peanut

Geographical distribution. Union of South Africa, Madagascar, Tanganyika Territory, Uganda, Senegal, Gambia, Sierra Leone, Java.

Induced disease In peanut, yellowing of young leaves, at first with green veins;

leaflets Seed formation innibited Ashnormal prohiferation of tissues.

Transmission By grafting By both winged and wingless individuals of the sphid, Aphis laburus Kalt (= A legumnosae Theob) (APHIDIDAE). Not by 13 tested species of leathoppers. Not by inoculation of expressed june. Not through seed from diseased plants. Not through seed.

Literature Hayes, Trop Agr., 9, 1932, 211-217; McClintock, Science, 45, 1917, 47-48, Soyer, Publ Inst Nat. End. Agron. Congo Belge, Sér Ser., 21, 1939, 23 pages (Rev. Appl. Mycol., 19, 1946,

59-63.

33. Marmor trifolli H (loc. cit , 93)

saic virus.

Hosts: LEGUMINOSAE—Trifolium pratense L., red clover, Lathyrus odoratus L., sweet pes; Vicia faba L., broad bean. Experimentally, also Trifolium hybridum L., alsike clover, T. incarnatum L., crim. son clover; T. repens L., white clover; Melilotus alba Desr., white sweet clover;

Pisum sativum L., pea.

Insusceptible species: LEGUMINO-SAE-Phascolus rulgaris I., bean; P. ourcus Roxb., mung bean; Medicago satira L., alfalfa. SOLANACEAE-Lucapersicon esculentum Mill., tomato; Nicotiana tabacum I., tobacco; N. glutinosa L.; N. langsdorffii Weinm.; N. rustica L.; N. sylvestris Spegaz, and Comes: Solanum tuberosum I., potato.

distribution: Geographical United States.

Induced disease: In red clover, yellow color along veins, but no mottling. Sometimes small yellow spots in interveinal areas. Little or no stunting. In Vicia faba, experimentally, necrotic splotches or rings sometimes at site of inoculation. Clearing of veins followed by appearnnce of whitish bands along the veins. Stalks discolored, purplish. Diseased plants ore stunted and often die back to a point near the base of the stalk, inducing new growth from buds on the stem.

Transmission: By inoculation of expressed juice, using carborundum. By aphid, Macrosiphum pist Kalt. (APIII-DIDAE), without incubation period and without long retention Not by aphids, Macrosiphum solanifolii Ashm. (= M. gei Roch) or Aphis rumicis Linn. (APHIDIDAE)

Thermal inactivation: At 60° C in 10 minutes.

Laterature: Osborn, Phytopath, 27, 1937, 1051-1058; Zaumeyer, Jour. Agr. Res., 56, 1938, 747-772; Zaumeyer and Wade, Phytopath., 27, 1037, 1009-1013.

31. Marmor pachyrhizi spec. From New Latin Pachyrhizus, generic name of sincamas

Common name · Sincamas · mosaie virus. Host: LEGUMINOSAE-Pachyrhizus erosus (L.) Urb., sincamas (yam bean ).

Insusceptible species: LEGUMINO-SAE-Phaseolus vulgaris L , bean

Geographical distribution: Philippine Islands.

Induced disease: In sincamas, chlorotic mottling of foliage; in plants infected when young, dwarfing.

Transmission: By inoculation of expressed juice, in the presence of sand as obrasive. Through obout 25 percent of the seeds from infected plants. Not through soil, interlacing of roots, or easual contacts of leaves and stems. No insect vector is known.

Literature: Fajardo and Marañon, Philippine Jour. Science, 48, 1932, 129-112.

35. Marmor vignae spec. nor. From New Latin Vigna, generic name of cowpea, from family name of an Italian botanist, Domenico Vigna,

Common name: Cowpea-mosaie virus. Hosts · LEGUMINOSAE-Viena sinensis (L.) Endl., cowpea. Experimentally, also Phascolus lunatus L., lima bean.

Geographical distribution: United States (Arkansas, Oklahoma, Louisiana, Indiana, Georgia, Iowa, Mississippi, Kansas. New Jersey).

Induced disease: In cowpea, clearing of veins followed by chlorotic mottling, slight convex cupping of leaflets, shortened internodes, abortion of flowers, twisting of petioles, delayed maturity. Malformation of leaves, stunting of plants, and reduction of yield more pronounced in some varieties of cowpea than in others.

Transmission: By inoculation of expressed juice, especially in the presence of fine carborundum powder. By aphids, Macrosiphum solanifolii Ashm , M. pisi Kalt., Aphis gossypii Glov. (APHIDI-DAE); not by various beetles nor by the bean leafhopper, Empoasca fabas LeB. (CICADELLIDAE). Through 5 per cent of seeds from infected cowpen plants.

Thermal inactivation. At 72 to 75° C in 10 minutes. Other properties: Infectious in dilu-

tions as high as 1:1000 and after 2 days

storage in expressed juice at room temperature, 20 to 25° C.

Laterature: Elliott, Phytopath., 11, 1921, 146-148, Gardner, Indiana Acad. Science Proc., 56, 1927, 231-247, 57, 1928, 417, McLean, Phytopath, 51, 1941, 420-430; Smith, Science, 60, 1924, 268.

36. Marmor repens Johnson (Phytopath., 32, 1942, 114.) Prom Latin repens, unlooked for, in reference to unexpected discovery of this virus as a constituent of a complex formerly regarded as a single virus, so-called "white-clover mosaie virus".

Common name : Pea-wilt virus.

Hosts LEGUMINOSAE—Tryfolum repens L., white clover. Experimentally, shot Lathyrus advartus L., Lene seculenta Moenchi, Lupinus albus L., Medicago lupulina L., Melilotus alba Dear, Phaeselus aureus Roxb., mung bean, Perlagaris L., bean, Pisum aditioum L., pea. Tryfolum hybridum L., T. incarnatum L., T. pratense L., Virag faba L., V. satius L.; Vigna sinensis (L.) Endl. cowpea

Insusceptible species CARYOPHYL. LACEAL-Stellaria media (L.) Cvrill CHENOPODIACEAE-Beta pulgaris L. Spinacia oleracea I. COMPOSI-TAE-Callistephus chinensis Necs. Lactuca satua L.; Taraxacum officinale Weber, Zinnia elegans Jaca. CRUCI-FERAE-Barbarea vulgaris R Brassica oferacea L. Raphanus sativus I. CUCURBITACEAE-Cucumis 2atiens L. ORAMINEAE-Zea mous L. LEGUMINOSAE-Glycine max Merr . Lupinus hirsulus L. Medicago salira 1. LILIACEAE-Lahum formosanum Stanf PLANTAGINACEAE-Plantago lanccolata L., P major L. POLY-GONACEAE-Rumez acetosella SCROPHULARIACEAE - Antirchinum majus I. SOLANACEAE-Datura stramonium L. Lycopersican esculentum Mill , Nicotiana glutinosa L ; N rustica L., N sylvestris Spense and Comes, \ tahacum L., Solanum niurum L

Geographical distribution: United States (Washington).

Induced disease. In white clover, systemic chlorotic mottling In pea, experimentally, originally infected leaves wilt and die, remaining attached to the stem by their abriveled petioles; a few advacent lower leaves may also wilt and die: in most varieties the top foliage remains ereen, but in two varieties, Alaska and Canada White, it mottles faintly, stems show faint gravish discoloration; plants are retarded in growth and dwarfed. If pea-mottle virus, Marmor efficiens Johnson, is also present, a severe streak disease occurs Intracellular inclusions absent In mung bean, experimentally, necrotic zonate local lesions In cowpen. experimentally, brown necrotic local lesions in inoculated primary leaves. diffuse areas of bleaching in uninoculated trifoliate leaves In bean, experimentally, mild chlorotic mottling except in three varieties that appear insusceptible (varieties Ideal Market, Kentucky Wonder, and Navy Robust).

Transmission By inoculation of expressed time. Not by dodder, Cuscula campestris Yunch (CONYOLYULA-CEAE) Not by pea aphid, Macrosiphum pisi Kalt (APHIDIDAE). No insect vector is know.

Thermal inactivation At 58 to 60° C in

10 minutes
Filterability Passes Berkefeld W filter candle

Other properties Infectious in dilution of 1:100,000 Not inactivated by storage in juice of infected plants at about 25° C for one month or by similar storage in dried traues of infected pea plants

Literature Johnson, Phytopath, 55, 1942, 103-116, Pierce, Jour Agr. Res., 51, 1935, 1017-1039

37 Marmor fastidiens apec nov. From Latin fastidiens, disdaining, in reference to slight irregularities in the reported host ranges of constituent strains and failure of this virus to infect certain varieties of the pea although it may utilize many other varieties of this species as host.

Common name: Alsike-clover mosaie virus.

Hosts: LEGUMINOSAE—Trifolium hybridum L., alsike clover; Pisum sadivum L., pea (except the varieties Horal, Perfection, and Surprise). Experimentally, also Crotalaria striata DC.; C. retusa L.; and C. spectabilis Roth (the two last-named species are reported to be insusceptible to the type strain of the virus, but susceptible to one or more of the other tested strains); Lupinux abus L.; L. angustfolius L.; Mediagos abus L.; L. angustfolius L.; Mediagos abus L.; Medilotus albo Desr.; Phascolus culgaris L., bean; Trifolium incarnatum L.; T. ryatense L.; Veta foba L.

Insusceptible species: SOLANA-CEAE-Datura stramonium L., Nicotiana glauca Graham; N. glutinosa L.; N. tabacum L.; Petunua hybrida Vilm. LEGUMINOSAE-Phaseolus aureus Roxb., mung bean; P. lunatus L., sieva bean; Soja maz (L.) Piper, soybean; Tryfolium repens L., white clover; Vicia sativa L., spring vetch.

Induced disease: In pea and bean, experimentally, systemic chlorotic mottling; some isolates kill inoculated leaves and even cause death of infected plants.

Transmission. By inoculation with expressed juice, at dilutions to 1:6000 or 1:8000 No insect vector is known.

Thermal mactivation At 60 to 65° C in 10 minutes; one strain at lower temperature, 54 to 58° C.

Straus. Several strains have been distinguished by the severity of their effects on host plants. These may be characterized as follows: var. fastindens, var. nov., type variety, the first of the strains to be described (originally known as alsike clover mosaic virus 1), induces mild disease in pea, does not infect med charer; var. mite, var. nov., described as pea mosaic virus 4, induces mild symptoms on pea, infects red clover; var. reprimens, var nov., described as pea mosaic virus 5, stunts peas severely; var. denudans, var. nov., described as alsike clover mosaic

virus 2, defoliates pea plants. Varietal names from New Latin fastidiens, epithet of the species, and from Latin metis, mild; reprimere, to restrain; and denudare, to denude; all three in reference to induced symptoms.

Literature: Wade and Zaumeyer, Phytopath., 28, 1938, 505-511; Zaumeyer, Jonr. Agr. Res., 60, 1940, 433-452.

38. Marmor iners spec. nov. From Latin iners, sluggish or inert, in reference to failure of the virus to spread systemically in certain of its hosts.

Common name: Pea-streak virus, Hosts: LEGUMINOSAE-Pisum satuum L., pea. Experimentally, also

Dest.; Lupinus angustifolius L., blue lupin; L. Iuleus L., yellow lupin; L. mulabilis Sweet; Phaseolus vulgara L., bean; Trifolium arueuse L., haresloo trefoil; T. cernuum Brot., nodding clover; T. fragyferum L., strawberry clover; T. giomeratum L., cluster clover; T. tyrateuse L., red clover; T. repens L., red clover; T. repens L., white clover; T. repens L., white clover; Veia vullous Roth., hairy vetch. CUCUB-BITACEAE—Cucums melo L., rock melon; G. sativus L., cucumber; Cucurbita prop L., marrow.

Insusceptible species: CHENOPODI-ACEAE-Spinacia oleracea L., spinach, Beta vulgaris L , beet. COMPOSITAE -Cotendula officinalis L . calendals; Lactuca satu a I.., lettuce; Zinnia elegans Jacq , zinnia. CRUCIFERAE-Brassica napus L , swede; B oleracea L , cabbage; B. rapa L , turnip; Matthiola incana R Br., stock; Raphanus sativus L., radish, Sisymbrium officinale (L.) Scop, LEGUMINOSAEhedge mustard Arachis hypogasa L , peanut; Lathyrus latifolius L , perennial sweet pea; L. pubescens Hook, and Arn., Argentine sweet pea; Lotus corniculatus I ..; Lupinus arboreus Sims, tree lupin; Medicago arabica Huds ; M. sativa L., lucerne (alfalfa); Phaseolus multiflorus Willd., runner bean: Trifolium strintum L. striated clover. T. subterraneum I., subterranean clover: Vicia faba L., broad bean PLANTAGINACEAE - Plantago lanceoluta L., plantain. SCROPHU-LARIACEAE-Antirrhinum marus L. SOLANACEAE-Cunhamandra between Sendt., tree tomato: Datura stramonium L. Junson weed: Nicotiana glauca R. Grah ; N rustica L., Turkestan tobacco; N. tabacum I., tobacco, Physalia peruviona L. Cape gooseberry: Solanum nigrum L , black nightshade. TROPAE-OLACEAE-Tropgeolum manus L . nas-UMBELLIFERAE-Anum turtuim grancolens L., celery.

Geographical distribution. New Zea-

Induced disease. In the pea, stunting, wilting of young leaves, purple or purple. brown spotting on young leaves, dark streak on stem Near tip, stem may die Stem becomes brittle, tip bent to one side Pods may remain flat and turn dark purple or purple-brown, or if already formed may show nurnle or nurnle-brown markings. Older leaves turn vellow. then brown and shrivelled. Infected plants usually the within tan or there weeks In inneulated plants small brown primary lesions, rapidly increasing in size especially along veins, eventually involve the whole leaf; betiole and stem streak follows Among garden peas, the varieties Pride of the Market, Little Marvel. Wm Massey and Autoemt are little offeeted; among field peas, the varieties Unica and White Ivory are consily resisin encumber, experimentally, numerous brown, necrotic local lesions. each with light colored center and sur rounding light-yellow halo. In bean, experimentally, local and systemic neero ers, stem streak, death of plant.

Transmission By inoculation of expressed juice, best with an almassic powder such as fine eard. Not by Myrus persicae (Sule), Macrosephine solan (APHIDIMAE), nor Things foliac Lind, (THRIPIDAE). No insert vector is known. Thermal inactivation: At 78 to 80° C in 10 minutes.

Filterability: Passes Mandler filters of preliminary, regular, and fine grades.

Other properties: Dilution end point 1:10. Not inactivated at room temperature in 41 days.

Literature Chamberlain, New Zealand Jour. Science and Technology, 20, 1939, 365A-3S1A.

39. Marmor efficient Johnson. (Phytopath., 52, 1912, 111.) From Latin efficients, effective, in reference to ability of this virus to cause motiling in all tested varieties of pea in contrast with mability of pea-ult virus, a second constituent of the complex earlier known as "whiteclover mosaic virus," to produce such chlorotic symptoms in tested varieties other than Alaska and Canda White.

Common name Pearmottle virus.

Bosts: LECUMI NOSAE—Trifolium
repers L., white clover, Pisum satiteum
L., pea. Experimentally, also CARYOPHYLLACEAE—Stellaria media (L.)
Cytill. CHENOPODIACEAE—Spinacia oleracia L., spinach. CUCURBITACRAE—Cucumis satitus L. LEGUMI NOSAE—Lathyrus adoratus L.;
Lens esculenta Monell., Lupinus albus

enlgaris L., bean; Trifolium hybridum L., T. incarnatum L., T. pratense L.; Vicia foba L., V. satira L. SCRO-PHULARIACEAR—Anturhinum manes L.

Insusceptible species CHENOPODI-ACEAE—Beta valgaris L., sugar beet, COMPOSITAE—Callistiphus chinensis Nees, Lactura sativa L., Tarazacum ofirinale Weier, Zinnia Higosa Jaca, CRUCHFERAE—Barbarta valgaris R. Br., Brasina chirata L., Raphamu sativas L. GRAMINEAE—Zea mays L. LEGUMINOSAE—Glycine max Metr., Vigna sincessa (C.) Loud. LILI-ACEAE—Litum formannum Stapt. PLANYAGINACEAE — Plantago lanccolata L.; P. major L. POLYGON-ACEAE-Rumex acclosella L. SOLAN-ACEAE-Datura stramonium L.; Lycopersicon esculentum Mill.; Nicotiana glutinosa L.; N. rustica L.; N. sylvestris Spegaz. and Comes; N. tabacum L.; Solanum nigrum L.

Geographical distribution United States (Washington).

Induced disease: Experimentally, in pea, developing leaves late in opening; clearing of veins, chlorotic spotting, stunting, chlorotic mottling; stipules mottled; stems, pods, and seeds appear normal. If pea-wilt virus (Marmor repens Johnson) is also present, a severe streak disease occurs. Intracellular inclusions absent. In bean, light yellow spots and clearing of veins. In spinach, severe chlorotic mottling, dwarfing. In alfalla, streaks of yellowing along veins, chlorotic mottling.

Transmission By inoculation of expressed juice. By dodder, Cuscuta campestris Yunck. (CONVOLVULACEAE). Not by pea aphid, Macrosiphum pisi Kalt. (APHIDIDAE). No insect vector is known.

Thermal inactivation At 60 to 62° C

Filterability · Passes Berkefeld W filter

Other properties: Infectious in dilution of 1:10,000 and after storage in expressed juice or dried tissues for one month at about 25° C.

Literature Johnson, Phytopath, 32, 1942, 103-116; Johnson and Jones, Jour Agr. Res., 64, 1937, 629-638, Pierce, ibid., 51, 1935, 1017-1039; Zaumeyer and Wade, ibid., 51, 1935, 715-749.

40. Marmor tritici H. (loc. cit., 61). From Latin triticum, wheat.

Common names Wheat-mosaic virus, wheat-rosette virus.

Hosts: GRAMINEAE—Trilicum aestrum L., wheat, Sceale cereale L., 19c. Experimentally, also all tested species of the tribe Hordeae; Trilicum compactum Host; T. turgidum L.; T. durum Desf.;

T. dicoccum Schrank; T. spella L.; T. polonicum L.; T. monococcum L., Hordeum vulgare L., barley.

Insusceptible species: GRAMINEAE
—Bromus inermis Leyss., awnless bromegrass (of the tribe Festuceae).

Geographical distribution: United

Geographical distribution: United States, Japan.

Induced disease: In wheat, systemic chlorotic mottling, with dwarfing in some varieties; vacuolate, rounded intracellular bodies in diseased cells, usually close to nucleus. Some selections of Harvest Queen wheat are resistant.

Transmission: Through soil, remains infectious in soil for more years. By inoculation of expressed julee (needle punctures in stem). Not through seeds or stubble of diseased plants. No insect vector is known.

Thermal inactivation: Contaminated soil becomes incapable of infecting wheat plants if heated for 10 minutes at 60°C though not if heated for the same length of time at 50°C.

Literature: Johnson, Science, \$6, 1912, 610, McKinney, Jour. Agr. Res., \$4, 1923, 711-809; U. S. Dept. Agr., Glin. 344, 1925; U. S. Dept. Agr., Circ. 442, 1937; Jour. Agr. Res., \$40, 1930, 547-555; McKinney et al., bid. \$2, 6, 1923, 693-695; Wada and Hukano, Agr. and Hort., \$9, 1934, 1773-1709 (Rev. Appl. Mycol., 14, 1935, 618, Abst.), Jour. Imp. Agr. Erp. Sta., \$3, 1937, 93-193 (Rev. Appl. Mycol., 16, 1937, 655, Abst.); Webb, Jour. Agr. Res., \$5, 1937, 655, 581-584, 56, 1923, 53-75.

41 Marmor graminis McKinney. (Jour. Washington Acad Sci., 54, 1944, 325) From Latin gramen, grass.

Common name: Brome-grass mosaic

Hosts: GRAMINEAE—Bromus incrmis Leyss., awiless brome-grass. Experimentally, also Triticum aestirum L., wheat; Avena saira L., cat.

Geographical distribution United States (Kansas).

Induced disease: In awaless bromegrass, systemic chlorotic mottling of the type commonly called yellow mosaic because of the distinctly yellow color of the chlorotic areas in affected leaves.

Transmission: By inoculation of expressed juice or of aqueous suspensions of dried diseased tissues; not inactivated by drying in diseased tissues for at least 51 days. No insect vector is known.

Literature: McKinney et al., Phytopath., 52, 1942, 331.

42. Marmor abaca II. (foc. cal., 63). From common name of host plant.

Common name: Abaeá hunchy-top

Host MUSACEAE-Musa textilis

Insusceptible species: MUSACEAE— Musa sapientum L. vars. cinerea (Blanco) Teodoro, compressa (Blanco) Teodoro, lacatan (Blanco) Teodoro, and suarcoleus (Blanco) Teodoro, M. catendishi Lamb.

(Blanco) Teodoro, M. catendishti Lamb. Geographical distribution: Philippine Islands.

Induced disease In aboog (Manula hemp plant), chlorotic lines and spots along veins of young leaves, followed by growth of distorted leaves, successively shorter, narrower, stiffer, and more surfed along their margins. The green areas of mottled leaves, petioles, and leaf sheaths are darker than normal. Newly formed diseased leaves unfurl early, but are slint, producing the bunchy top that is referred to in the common name of the disease.

Transmission By the aphid, Pentalonia nigronerrosa Coq. (APHIDI-DAE), vector also of the apparently distinct banana bunchy-top virus of Australia. The inculuation period of alactalia transmission of the apparent of viruliferous aphids do not receive the virus directly, but must feed on dreased plants before they can infect healthy alaca. Transmission by Inoculation of expressed junce has not been demonstrated. No soul transmission.

Literature . Ociemia, Am. Jour. Bot.,

17, 1930, 1-18; Philippine Agriculturist,
 22, 1934, 567-581.

 Marmor passifiorae II. (loc. cit.,
 From New Latin Passifiora, generic pame of passion fruit.

Common name · Passion-fruit woodi-

Hosts: PASSIFLORACEAE—Passifora edults Sims, passion fruit; P. cocrulea L. Experimentally, also P. alba Link and Otto.

Insusceptible species: SOLANA-CEAE—Datura stramonium L.; Lycopersucon escutentum Mill., tomato; Nicotiana alutinosa L.: N. labacum L., tobacco.

Geographical distribution: Australia (New South Wales, Queensland, Victoria), Kenya

Induced disease In passion fruit, growth checked jleaves puckered, slightly chilorate or obscurely multiel, curied, tursted, deformed. Clearing of veins has been observed. Color of stems draker green than normal in some places. Fruits short or deformed, duscolored, surface sometimes roughened by cracks; so hard as not to be cut through readily. Pericarp or rind of fruit abnormally thick. Pulp deficient, color deepened. At temperatures below 80° F, some abscussion of young chlorotic leaves; above 85° F, masking of the disease; above 85° F, masking of the disease; now thanks.

Transmission By inserting estion in attention wound after sonking it in expressed tunce of diseased plant. By apinds, Myrus persicae (Sulz.), Macrosyphum solanifolis Asium, and two dark-colored species of the genus Aphie (APHIDIDAT).

Laterature Cobb, Agr. Gaz. New South Waley, 12, 1901, 407-418, Noble, Jour. and Proc. Roy See. New South Wales, 62, 1928, 79-95, Noble and Noble, 1914, 72, 1933, 293-317; Summond, Queensland Agr. Jour., 45, 1936, 322-330

41. Marmor flaccumfaciens II. (loc. cst., 73). From Latin flaccus, flabby, and facere, to make.

Common names Rose-wilt virus, rose dieback virus,

Hosts: ROSACEAE—Rosa hybrids, roses.

Geographical distribution: Australia, especially Victoria; New Zealand; possibly Italy.

Induced disease: In rose, leaflets crowd ed, brittle, recurred. Defoliation progresses from tip to base of plant. Tips of branches discolor and die back an inch or two. Stem darkens at base. Buds remain green and begin development, but growth is soon checked by necrosis at tips. Plant may recover temporarily, but not permanently.

Transmission: By inoculation of expressed juice (needle-puncture and scratch methods). No insect vector is known.

Filterability Passes Seitz filter (Seitz EK Schichten type, size 6).

Literature: Gigante, Boll. Staz. Pat. Veg. Roma, n. s. 16, 1936, 76-91; Griere, Austral. Jour. Exp. Bol. and Med. Science, 8, 1931, 197-121; Jour. Dept. Agr. Victoria, 1932 and 1933, pages 30-32.

45. Marmor rosae H. (loc. cit., 74). From Latin rosa, rose.

Common name: Rose-mosale vieus.

Hosts ROSACEAT—Rosa rugosa
Thunb.; R. chimensis Jacq. var. manelu
Dipp.; R. mullifora Thunb ; R. odorala
Sweet, tea rose; R. symnocarpa; Rubus
partiforus Nutt.

Geographical distribution: United States, England, Bulgaria, Brazil.

Induced disease: In Rosa rugosa and R. chinensis var. manelli, systemic chlorotic mottling.

Transmission: By budding and other forms of graftage. Not by inoculation of expressed juice. No insect vector is known.

Literature Baker and Thomas, Phytopath., 32, 1942, 321-326; Brierley, Phytopath., 25, 1935, 8 (Abst.); Brierley and Smith, Am. Nurseryman, 72, 1949, 5-3; Jour. Agr. Res., 61, 1940, 525-560, Kramer, Revista de Agricultura, 6, 1940, 301-311; O Biologico, 6, 1949, 385-383, McWhorter, U. S. Dept. Agr., Plant Dis. Rep., 16,

1931, 1-3; Mtlbrath, West. Florist, 18, 1630, 22-30; Kelson, Phytopath., 29, 1930, 130 (Abst.); Newton, Rep. Dorata. Det., 1930, Div. Bot., Canad. Dept. Agr., 1931, 23; Thomas and Massey, Hilgardia, 1f, 1939, 615-63; Vlbert, Jour. Soc. Imp. et Cent. Hort., 9, 1863, 144-145, White, Phytopath., 22, 1932, 53-50; 24, 1931, 1121-1125.

46. Marmor venentierum H. (loc. ct., 75). From Latin venentier, poisonous, in reference to occasional killing of tissues near inserted bud in graft transmission.

Common name: Rose-strenk virus, Hosta: ROSACEAE—Rosa multifora Thunb.; R. odorata Sweet; Rosa hybrids. Geographical distribution: Eastern United States.

Induced disease: In various rose species and hybrids, brownish or reddish ring and veinbanding patterns on leaves, and ring patterns on stems. Sometimes necrotic areas near inserted bud, causing girdling of stem and witting of foliage.

Transmission: By grafting. Not by inoculation of expressed juice. No insect vector is known.

Literature: Brierley, Phytopath., 25, 1935, 7-8 (Abst.); Brierley and Smith, Jour. Agr. Res., 61, 1940, 625-660.

47. Marmor mall H. (loc. cit., 75). From Latin malus, apple tree.

Common name. Apple-mosaic virus.

Hosts: ROSAGEAE—Fyrus nalus L.

apple. Experimentally, also Colonicald
harroriana; Ericolitya papanca India,
logust: Photonia arbutiolia Ilial,
logust: Photonia arbutiolia Ilial,
toyon; Rosa sp., rose; Sorbus palleteen.

Insusceptible species: ROSACEAE— Amelanchier almifolia Nutt.; Cratacqus douglass: Lindl.; Pyrus communis L, pear.

Geographical distribution: United States, Australia, Bulgaria, British Isles. Induced disease: In apple, clearing of

raduced discusser in approve veins and systemic chlorotic spotting. The chlorotic areas sometimes become necrotic during months of intense sun-

Transmission: By grafting No insect

possessing polar flagella. Gram-negative. Gelatin colonics Small, finely granular. fluorescent with dark center, surrounded berrs : a yellow zone, with pale gray margin. Source Isometrin stab: Dirty-white surface in eight becoming greenish, fluorescent 'ction.

li Pretimens thernies: Circular, raised, smooth, and furthers the true at artice, with fluorescent zone (Smill atheres G 1:1 P. riphery.

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Sopplied Bal. ha. 7, 1, 122 Unchanged.

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Potato Scant, olive green growth

Kitrites produced from entrates

Blood serum Eque Sed in 5 days Aerokic, facultative

Optimum temperature &C.

19 Pseudomonas oleovorans Lee an 1 Chandler, (Jour Bact, 41, 1941, 375) Short rade 0.5 by 0.3 to 1.5 micrors,

Celutin stab No Industrial after a

Litmus milk: Not coagulated. Potato: Glistening. reddish-brown growth.

Indole not formed. Nitrites produced from nitrates.

Aerobic, facultative, Optimum temperature 20°C.

Distinctive characters: Resembles Pseudomonas viscosa Migula.

Source: Found in water and soils in

Kent. England. Habitat: Water and soil.

24. Pseudomonas ovalis Chester. (Bacillus fluorescens oralis Ravenel, Memoirs Nat. Acad. Sci., 8, 1896, 9; Chester, Determinative Bacteriology, 1901, 325; not Bacillus oralis Wright, Memoirs Nat. Acad. Sci., 7, 1895, 436.) From ovum, egg; M. L oval.

Rods: 0.3 to 0.7 by 0.7 to 1.3 microns. occurring singly. Motile, possessing a single polar flagellum. Gram-negativa. Gelatin colonica: Irregular, lobata,

slightly granular. Gelatin stab: No liquefaction.

Agar colonies: Circular, opaque, entire, greenish fluorescence.

Agar slant: Thick, white, becoming greenish, fluoreacent.

Broth: Turbld, with pollicle.

Litmus milk: No roagulation: alkaline. Potato: Luxuriant, dirty-brown.

Indole not formed. Nitrites not produced from nitrates.

Starch not bydrolyzed.

Blood scrum not liquefied.

Acid from glucose.

Acrobic, facultative

Optimum temperature 25°C.

Habitat: Soil. Has been found in intestinal canal.

25. Pseudomonas strista Chester. (Bacillus striatus viridis Ravenel, Memoirs Nat. Acad. Sci., 8, 1896, 22; Chester, Determinative Bacteriology, 1901, 325.) From Latin, strio, streak, groove.

Slender rods, of variable lengths, stain-

canes remain short and become resetted.

Transmission: By aphids, principally

Amphorophora rubi Kalt., but also A. rubicola Oestl. and A. sensoriata Mason (APHIDIDAE). Not by inoculation

of expressed juice.

Literature: Bennett, Michigan Agr. Exp. Sta., Techn. Bull. 89, 1927; 125, 1932; Cooley, New York Agr. Exp. Sta. (Geneva), Bull. 675, 1936; Harris, Jour. Fom. and Hort. Science, 11, 1933, 227–255; 17, 1940, 318–343; Rankin, New York Agr. Exp. Sta., Geneva, Bull. 543, 1927; New York Agr. Exp. Sta., Geneva, Tech. Bull. 175, 1931.

Marmor persicae H. (Holmes, loc. ct., 81; Flavamacula persicae McKinney, Jour. Washington Acad. Science, 34, 1944, 149.)
 From New Latin Persica, former generic name of peach.

Common name Peach-mosaic virus.
Hosts: ROSACEAE—Prunus persica
(L.) Batsch, peach and nectarine, all
tested varieties. Experimentally, also
P. armeniaca L., apricot; P. communis
Fritsch, almond; P. domestica L., plum
and prune.

Insusceptible species: Attempts to infect sweet and sour cherries have thus far failed.

Geographical distribution: United States (Colorado, California, Utah, Oklahoma, Texas, New Mexico, Arizona),

Induced disease In peach, short internodes in spring growth, sometimes breaking in flower pattern, chlorotic mottling and distortion of foliage early in season, masking of leaf symptoms or excision of affected areas of leaf lamina in midsummer; fruit small, irregular in shape, unsalable. Some peach varieties are less damaged than others, but all are thought to be equally susceptible to infection, and equally important as reservoirs of virus when infected. In almond, experimentally, symptomiess infections; symptoms appear in some apricot and plum varieties when experimentally infected, not in others.

Transmission · By budding and other

methods of grafting. Not by inoculation of expressed juice. Not through soil. No insect vector is known. Not through pollen or seed from diseased plants.

Thermal inactivation: Not demonstrated; virus not inactivated by temperatures effective in inactivating peach-

yellows virus.

Literature: Bodine, Colorado Agr. Exp. Sta., Bull. 421, 1936; Bodine and Durrell, Phytopath., 51, 1941, 322-333; Calion. ibid., 24, 1934, 1380-1381; Christof, Phytopath. Ztschr., 11, 1933, 369-422; Cochran, California Cultivato, 87, 1940, 164-165; Cochran and Hutchins, Phytopath., 28, 1938, 800-892; Hutchins, Science, 76, 1932, 123; Hutchins, Science, 76, 1932, 123; Hutchins, 84, 1935, 1941, 1

Marmor astri H. (loc. cil., 83).
 From Latin astrum, star,
 Common name: Peach asteroid-spot

virus.
Host: ROSACEAE-Prunus persica

Host: ROSACEAE-Prunus persico (L.) Batsch, peach.

Geographical distribution: California. Induced disease: In peach, discrete chlorotic lesions appracial galong veint, forming star-like note; developing have normal in appearance, becoming affected as they mature. Some chlorophyll retained in lesions as leaves turn yellor. Affected leaves abed early.

Transmission: By grafting. Not by inoculation of expressed juice. No insect vector is known.

Literature: Cochran and Smith, Phytopath., 28, 1938, 278-281.

53. Marmor rubiginosum Reeves. (Phytopath., 50, 1940, 789.) From Latin rubiginosus, rusty.

Common name: Cherry rusty-mottle

Nost: ROSACEAE—Prunus arium L. sweet cherry. vector is known. Transmission by inoculation of expressed juice has not been demonstrated.

Thermal inactivation: Not demonstrated, Virus in stem tissues withstands at least 50° C for as much as 60 montes without being inactivated.

Literature: Blodgett, Phytopath, 28, 1938, 937-938; Bradford and Johey, Jour, Agr. Res., 46, 1933, 901-908; Christoff, Phytopath. Zeitsehr., 7, 1934, 521-536; 8, 1935, 285-296, Thomas, Hilgardan, 16, 1937, 581-584.

48 Marmor fragarise II. (loc. cit., 78) From New Latin Fragaria, generic name of strawberry, from Latin fraga, strawborrea.

Common name. Strawberry-erable

Hosts: ROSACEAE—Fragaria hybrids, cultivated strowberries. Experimentally, also Fragaria iesea L., woodland strawberry.

Geographical distribution. United States, England.

Induced disease In cultivated atrosberty, ernking and ethorosis of leaves At first, minute chlorotic fiecks appear in young leaves. There fiecks enlarge, and small necrotic spots may appear in their centers. Vein-clearing appears frequently. Affected foliage lighter and less uniformly green than normal. The variety Royal Sovereign may appear normal through carrying this virus.

Transmission By aphid, Myzus fragarfolii Ckll (= Capitopherus fragariae Throb) (APHIDIDAE) By grafting. Not by moculation of expressed mice.

Laterature: Harns, Ann. Rept. Last Malling Res. Sta. for 1936, 1937, 201-211, 212-221, ibid., for 1937, 1938, 201-202. Harris and Hildebrand, Canad Jour, Res., C. 15, 1937, 202-290, Optilie et al., Ann. Rept. Long Ashton Res. Sta. for 1933, 1931, 26-97, Vaughan, Phytopath, 25, 1933, 23-4710, Zaller, Orgen Agr. Exp. Sta., Sta. Bull. 319, 1933; Zeller and Vaughan, Phytopath., 22, 1932, 709-473. 49. Marmor marginans II. (loc. cit, 79). From Latin marginare, to provide with a margin.

Common name: Strawberry yellowedge virus.

Hosts. ROSACDAE—Fragara hybrids, strawberries; Fragara caltfornica C. and S. F. chiloensis Duch. (symptom-less). Experimentally, also Fragara execa L; F. repuisana Duch. (some clones appear to be immune to infection by runner instephins).

Geographical distribution. United States, England, France, New Zcaland.

Induced disease. In strawberry, plant appears flat with outer zone of leaves more or less normal, central leaves dwarfed, yellow-edged, deficient in red pigmentation. The variety Premier may carry this virus without showing any obvious manifestation of disease.

Transmission By aphid, Myzus fragacfolic Ckil. (APHIDIDAE). By grafting. Not by incculation of expressed purce. Not through seeds from discused plants.

Laterature: Chamberlain, New Zealand Jour. Agr., 49, 1031, 226-231, Harris, Jour. Pon. and Hort. Seience, 11, 1033, 56-76, Harris and Hildebrand, Canad, Jour. Res., 6, 16, 1937, 262-269; Hidebrand, ibid., C, 19, 1011, 223-233; Plakidss, Phytopatha, 16, 1020, 423-429, Jour. Agr. Res., 35, 1027, 1037-1039.

 Marmer rubi H. (Holmes, loc. ett., 80, Poccile rubi McKinney, Jour. Washington Acad. Science, 54, 1911, 148.)
 From Latin rubus, bramble bush.

Common name · Red-raspberry mosaic

Hosts. ROSACEAE—Rubus idaeus L., red raspberry; R. occidentalis L., black rispberry.

Geographical distribution: United

Induced disease: In red raspherry, aysterme chlorolic motiling, masked at high temperatures of summer. Foliage desciopment delayed in spring. In some varieties, leaf petioles and cane tips die, chlorotic bands surrounding discolored areas on leaves. In Mazzard cherry, dwarfing of whole plant, chlorotic bands on leaves.

Transmission: By budding, even in the absence of survival of inserted buds.

57. Marmor nerviclarens Zeller and Evans. (Phytopath., 51, 1941, 467.) From Latin terrus, sine w or nerve, and clarere, to shine.

Common name: Cherry vein-clearing virus.

Hosts. ROSACEAE—Prunus assum L., sweet cherry. Perhaps also P. serrulata Lindl, and P. domestica L., on which symptoms similar to those induced by this virus have been abserved.

Geographical distribution: United States (Oregon, Washington).

Induced disease: In sweet cherry, clearing of veins throughout each leaf or unly in localized areas. Margins of leaves irregular, most indented where clearing of veins is most conspicuous. Elongated. elliptic, or slot-like perforations occur in some leaves. Affected leaves usually narrow. Enations occur as small blistered proliferations un lower side af main veins. Upper leaf surface silvery by reflected light. By midsummer, leaves droop and appear somewhat wilted; they may fold along the midvein. Internodes short; increased number of buds, spurs. or short branches at nodes , rosetting more pronounced an some branches than on others, mostly at end of year-old wood. In advanced disease, fruits pointed, small, flattened on suture side with swollen ridge along suture. Blossoms abnormally abundant, crop of fruit reduced or wanting.

Transmission By grafting. Not demonstrated by inoculation of expressed juice. No insect vector is known.

58. Marmor viticola H. (loc cit., 83). From Latin citis, vine, and -cola, inhabitant of.

Common name Vine-mosaic virus. Host: VITACEAE—Vilis confera L., grape. Geographical distribution: France. Italy, Bulgaria, Czechoslovakia.

Induced disease: In grape, various modifications of systemic chlorotic mot-tling, and red pigmentation of parts of leaves with subsequent drying and dropping nut of affected spots. Leaves deformed, crimped between main veins Grawth restricted.

Transmission: By inoculation of evpressed juice and by pruning.

pressed juice and by pruning.
Literature: Blating, Vinafský obzar,
25, 1931, 4-5 (Cent. f. Bakt., 11 Abi., 26,
1931, 4-64); Ochrana Rostlin, 15, 1933,
104-105 (Rev. Appl. Mycol., 13, 1933,
422); Gigante, Boll. Star. Fat. Veg. Roma,
n.a. 17, 1937, 106-192 (Rev. Appl Mycol.,
17, 1938, 221); Pantanelli, Malpugha, 24,
1911, 407-623; 25, 1912, 17-49, Stransk, 11
Congr. Intern. Path. Comp. Paris, 1233,
267-378; Ochrana Rostlin, 11, 1931,
89-93 (Hev. Appl. Mycol., 11, 1932, 290);
Vielwerth, Ochrana Rostlin, 13, 1933,
38-90 (Rev. Appl. Mycol., 13, 1931,
4214-422).

59. Marmor santali II. (loc. cit, 94). From New Latin, Santulum, generic name of sandal.

nt sandal.

Common name: Sandal leaf-curl virus.

Host. SANTALACEAE—Santalum

album L., sandal.

Geographical distribution: India.

Ladurad disease: In sandal, lea

Induced disease: In sandal, leaves small, curled, wrinkled, thickened, brittle, abscissing. Systemic chlorotic mottling. Internode length normal. Infected twigs produce both flowers and fruits.

Transmission: By ring bark-grafts Not by inoculation of expressed juice. No insect vector is known. Literature: Venkata Rao. Mysore San-

dal Spike Invest. Comm., Bull. 3, 1933.

60. Marmor secretum Bennett, (Phytopath., 54, 1944, 88). From Latin secretus, hidden.

Common name: Dodder latent-mostic

Hosts - CONVOLVULACEAE Cuscula conformica Choisy, dodder. ExperiGeographical distribution: United States (Washington).

Induced disease: In aweet cherry, chlorotic mottling 4 to 5 weeks after full bloom, first on small basal leaves, later on all leaves. The older affected leaves develop autumnal colors and absciss, 30 to 70 per cent of the foliage being lost. The remaining foliage appears somewhat wilted, shows increased mottling, ebborotic spots, and areas becoming yelfowsh brown, appearing rusty. Blossons normal. Fruits smaller than normal, inspired, not missbapen. Growth rate of tree reduced slightly.

Transmission. By grafting. Not by moculation of expressed juice. No insect

vector is known.

Literature. Reeves, Phytopath., 50, 1910, 789 (Abst.); Jour. Agr. Res., 62, 1911, 555-572 (see 566-567).

54 Marmor cerasi Zeller and Evans. (Phytopath., 31, 1941, 467.) From Latin cerasus, cherry tree; originally spelled cerasac, by error

ceratue, by error

Common name. Cherry mottle-leaf virus.

Hosts ROSACEAE—Prunus acium L., sweet cherry, P. emarginata (Dougl.) Walp, wild cherry. Experimentally, also P. cerasus L. (tolerant) and P. mohaleb L. (tolerant).

Geographical distribution. United States (Washington, Oregon, Idaho, Calitornia) and Canada (British Columbia).

Induced disease. Insweet clierry, chlorotte motting, leaves puckered, armkied, distorted, not perforated. Blossoms not affected Fruit small, hard, mapild, unseen or delayed in ripening. Grop reduced. Branches shortened, tree eventually stunted

Transmission By budding. No insect vector is known. Not by the black cherry aphid, Myrus cerasi (I'.) (APHI-DIDAE). Not by inoculation of expressed juice

Thermal inactivation. Not demon strated, not at 46° C in 60 minutes nor at 49° C in 10 minutes in bud sticks. Literature: Reeves, Washington State Hort. Assoc. Proc., 31, 1935, 85-89; Jour. Agr. Res., 62, 1941, 555-572; Zeller, Oregon State Hort. Soc. Report, 26, 1934, 92-95: Phytopath., 31, 1941, 463-467.

55 Marmor lineopictum Cation (Phytopath., 31, 1911, 1009.) From Latin linea, line, and pictus, ornamented. Common names: Prunus line-pattern

virus, peach line-pattern virus,

Host's, ROSACEAE—Prunus salicina Lindl., Japanese plum, P. mahaleb L., Mahaleb cherry; P. persica (L.) Batsch, peach (= Amyadalus persica L.).

Geographical distribution: United States (Kentucky, Michigan, California, Ohio; perhaps widely distributed).

Induced disease. In peach and Maladeb cherry, light-colored line patterns or faint chlorotic mottling, tending to become masked as leaf becomes old. In peach, affected foliage sometimes less glossy than normal. In Prunus solicina, no disease manifestations usually, rarely, ethorotic mottling on a few leaves.

Transmission · By grafting. No insect vector is known.

Laterature, Berkeley, Div. of Bot. and Plant Path., Science Service, Dominion Dept. Agr., Ottowa, Canada, Pabl. 679, 1911; Catton, Phytopath., 31, 1911, 1903– 1910, Thomas and Rawlins, Hilgardia, 12, 1929, 623-611; Yalleau, Kentucky Agr. Exp. Sta. Res. Bull. 327, 1932, 89-103.

56. Marmor palidolimbatus Zeller and Milbrath. (In Handbook, of Virus Discases of Stone Fruits in North America, Michigan Agr. L'sp. Sta., Miscell. Pubi., May, 1942, 59, Phytopath., 32, 1942, 633.) From Latin palidus, pale, and Imbatus, bordered.

Common name Cherry banded-chilorosis virus.

Hosts: ROSACEAE-Prunus serrulata Lindl., fowering cherry; P. arium -L. Mazzard cherry,

Geographical distribution: United States (Pacific Northwest).

Induced disease: In flowering cherry,

Laubert, Gartenwelt, 31, 1927, 391; Pape, ibid., 26, 1927, 329-331; 32, 1928, 116-117; Pethybridge and Smith, Gard. Chron., 92, 1932, 378-370; Schmidt, Gartenwelt, 81, 1932, 40; Seeliger, Nachrichtenbl. Deutsch. Pflanzenschutzdienst, 6, 1926, 63-61; Tuimann, Gartenwelt, 31, 1927, 375-376; Verplancke, Bull. Cl. Sci. Acad. Roy. de Belgique, Ser. 5, 18, 1932, 269-281 (Rev. Appl. Mycol., 11, 1932, 649-650).

62. Marmor angliae H. (loc. cit., 48). From Latin Anglia, England.

Common name: Potato-paracrinkle virus.

Hosts: SOLANACEAE—Solanum tuberosum L, potato. Experimentally, also Datura stramonium L, Jimson weed. Insuaceptible species: SOLANA-CEAE—Nucotana tabacum L, tobacco. Geographical distribution: England.

Induced disease: In potato, masked in all plants of the variety King Edward. Chlorotic mottling with some necrosis the varieties Arran Victory and Arran Chief. Chlorotic mottling only in Arran Commute, Mnjestic, and Great Seet potatoes. Two varieties, Sharpe's Express and Epicure, are said to be resistant.

Transmission: By grafts. Not by inoculation of expressed juice. No insect vector is known.

Literature: Dykstra, Phytopath., 26, 1935, 597-696; Salaman and Le Pelley, Proc. Roy. Soc. London, Ser. B, 106,

1930, 140-175.

63. Marmor acvi spec. nov. From Latin acvum, old age, in reference to the obvious involvement of old, but not of young, delphinium leaves.

Common name. Celery-calico virus.

Hosts: CUCURBITACEAE—Cucumis sativus L., cucumber; C. melo L., cantaloupe; Cucurbita pepo L., summer crookneck squash. RANUNCULA-CEAE—Delphinium chinensis; D. formosum, hardy larkspur, D. grandiflorum, parryi; D. zalil. SOLANACEAE—Lycopersicon esculentum Mill., tomato.

UMBELLIFERAE—Apium graecolens L., celery. Experimentally, also SOLA-NACEAE—Nicotiana tabacum L., to-bacco; Petunia hybrida Vilm., petunia. VIOLACEAE—Viola cornuta L.

Geographical distribution. United States.

Induced disease: In celery, clearing of younger leaves, green islands of tissue in lemon-yellow areas of outer leaves, green and yellow zigzag bands on leaßes. In delphinium, basal and middle leaves with pale-orange, amber, or lemon-yellow areas; younger leaves normal green, chlorotic ring and line patterns.

Transmission: By inoculation of expressed juice in the presence of facely prowdered carborundum. By sphikis Aphis apigracolens Essig, celery lef aphid; A. apni Theob., celery sphid; A. ferruginea-strata Essig, rusty-banded aphid; A. gossypii Glov., cotton sphid; A. meddeleonis Thomas, erigenon root aphid; M. yours erretumflexus (Buckt), hiy aphid; M. convolenti (Kalt.), fargive aphid; M. peratuce (Sul.2), green peach aphid; M. pearsuce (Sul.2), green peach aphid; M. peach a

Literature. Severin, Hilgardia, 14, 1942, 441-464; Severin and Freitag, Phytopath., 26, 1935, 891 (Abst.); Hilgardia, 11, 1938, 493-558.

64. Marmor rathant spec. nov. From Latin raphanus, adish.

Common name Raduh-mosaic virus Hosts: CR'CIFERAE—Raphams saturus L, radish. Experimentally, site saturus L, radish. Experimentally, site CRUCIFERAE—Brassra oleraeca L; B, mgra (L.) Koelt; B, estati Buller; B, garensis (L.) Kitze.; B, pestati Buller; B, juncea (I.) Coss; B, rapa L; B edpressa Boiss, Gapsella bursa-pastaris (L.) Medic; Alatcomra marituma R, Br.; M. becornst DC. GHENOPODIAGEAE—Chenopodium album L; C, murali L; Spinacia oleraeca L. RANUNCULA. CEAE—Delphinum ajoas L. SOLA. NACEAE—Nicotiana glutinosa L.; N.

mentally, also CHENOPODIACEAE-Beta vulgaris L . sugar beet: Chenapadrum album L., lamb's quarters; C. murale L., sowbane. CONVOLVULA-CEAE-Cuscuta campestris Yuncker: C. subinclusa Dur. and Hile. CRUCI-FERAE- Crassica incana (L.) F. W. Schultz, mustard (tolerant). CUCUR-BITACEAE-Cucumis mela L., cantaloune. PHYTOLACCACEAE-Phytalacca americana L., pokeweed. PLAN-TAGINACEAE-Plantago major L. plantain. POLYGONACEAE-Fagopurum esculentum Moench, buckwheat; Polygonum pennsylvanicum L. Lnotweed PRIMULACEAE-Samolus floribundus HBK, water pimpernel. SOLANACEAE-Lucopersicon esculentum Mill., tomato, Nicatiana glauca Graham (tolerant): N. palmeri Grav: N. rustica L. (tolerant); N. tabacum L. (tolerant): Solanum tuberasum L., potato. UMBELLIFERAE-Aprum grateolens L., celery.

Insusceptable species: COMPOSITAE -Helianthus annuus L . sunflower: Lactyen saina L., lettuce. CRUCIFERAE -Rrassica oleracea L , cabbage. POLY-GONACEAE-Errogonum fasciculatum Benth , California buckwheat. SCRO-I'II ULARIACEAE-Verbascum thapaus L., mullein, SOLANACEAE-

Atropa belladonna L., belladonna. distribution Geographical United States (California).

Induced disease: In dodder, no symptoms. In sugar beet, experimentally, temporary systemic chlorotic spotting: occasional faded areas in leaves in subsequent chronic stage of disease. In cantalonge, experimentally, chlorotic spotting. reduction in leaf size, death of some haves, stunting of plant; melons small and of poor quality. In celery, experimentally, systemic chlorosis followed by dwarfing and mottling with subsequent apparent recovers.

Transmission By dodder, Cuscuta catefornica, C. campestris, and C. subinelusa. By inoculation of extracted juice to some, but not to other, bost plants, Phytolacea americana is readily infected by subbing of abrasive, and develops numerous negrotic primary lesions that serve for quantitative estimation of concentration of virus in inoculum. Through seeds from injected plants of dodder. Cuscuta campestria; not through seeds from diseased cantaloupe, buckwheat, or pokeweed plants. No insect vector is known. Thermal mactivation: At 56 to 60° C

methods in the presence of a small amount

in 10 minutes. Filterability: Passes celite and Berke-

fold N and W filters.

Other properties: Infective in dilutions to 1:3000. Inactivated by drying and by storage in expressed pokeweed inice, within 48 hours.

61. Marmor pelargonii spec. From New Latin Pelargonium, generic name of common gersnium.

Common names · Pelargonium leaf-curl virus, virus of dropsy or Krauselkrankheit of geranium.

GERANIACEAE-Pelargon-Host tum horiorum Bailey, geranium.

Induced disease In geranium, circular or irregular chlorotic spots, sometimes stellate or dendritle, 1 to 5 mm in diameter, centers becoming brown with chlorotic border; severely affected leaves become yellow and drop; spotted leaves ruffied, crinkled, malformed, small, sometimes puckered and splitting. Petioles and stems show corky, raised, necrotic streaks; tops may die. Disease most severe in spring, meonspicuous in sum-

Transmission: By grafting. Not by moculation of expressed juice nor by use of knife to prepare cuttings for propagation. Not through seed. No insect yector in known.

Literature Berkeley, Canad. Hort, and Home Mag., 1938, 1938, 1-4; Blattne. Ochrana Rostlin, 13, 1933, 145 (Rev. Appl. Mycol., 15, 1931, 378-379); Bremer. Blumen-u. Pflanzenbau, 48, 1933, 32-33 (Rev. Appl. Mycol., 12, 1933, 514); Halstend, New Jersey Agr. Exp. Sta., Rept. 14, 1893, 432-433; Jones, Washing. ton Agr. Exp. Sta., Bull. 390, 1910; fig; F. allissima Blume; F. krishna; and F. tsiela Roxb.

Geographical distribution: United States (California, Texas), England, Puerto Rico, China, New South Wales, Western Australia.

Induced disease: In fig, systemic chlorotic spating and mottling of foliage; some severe leaf distortion. Fruits sometimes affected, bearing light circular arcas, rusty spots, being deformed or dropped prematurely. Necrotic lesions on profichi of Samson caprifigs also have been attributed to section of this virus.

Transmission. By budding. No insect vector is known; mites have been susnected as ressible vectors.

Literature: Condit and Horne, Phytopath., 23, 1633, 857-506; 51, 1911, 561-651; 55, 1913, 719-723, 1ho and Li, Lingman Science Jour., 15, 1936, 69-70; Pittman, W. Austral. Dept. Agr. Jour., 12, 1935 196

67. Marmor Italicum (Fawcett) comb nov. (Cetrur staticum Fawcett, Phytopath., 31, 1911, 357.) Specific epithet menning "pertaining to Italy."

Common name Citrus infectious-mot-

Hest: RUTACEAE-Curus auron-

Geographical distribution: Italy.
Induced disease. In sour orange, white,

pale green, or yellow irregular areas in leaves, leaving narrow green bands along midrib; leaves blistered and distorted. Transmission: The aphid, Toxoptera

Transmission: The aphid, Toxoptera aurantii (Phytopath., 24, 1934, 661), has been suspected as vector. Literature: Fawcett, Phytopath., 11, 1941, 356-357; Petri, Bol. Staz. Pat. Veg. Roma, n. s. 11, 1931, 105-114.

Note: Several additional species were described too late for complete systematic treatment here. They are plain's wheat mosaic virus, Marmor campestre McKinney (Jour. Washington Acad. Sci., \$4, 1944, 324) with varieties lypicum McKinney and galbinum McKinney, respectively causing light-green mossic and severe yellow mosaic of wheat in Kansas; wheat streak-mosaic virus, Marmor virgatum McKinney (ibid., 54, 1944, 324) with varieties typicum Mckinney and viride McKinney (shid., \$4, 1944, 325), respectively causing yellow streskmosaic and green atreak-mosaic of wheat in Kansas; Agropyron-mosaic virus, Marmor agropyri McKinney (shid., 34, 1914, 326), with varieties typicum McKinney and florum McKinney, respectively causing green-mosale mottling and yellow-mosaic mottling in the grass Agropyron repens (I..) Beauv. in Virginia; also a virus, Flavimacula ipomese Doolittle and Harter (Phytopath., 35, 1945, 763), causing feathery mottle of sweet potato in Maryland [see Marmor persuane for treatment of a virus that was assigned as type of Flavimarula McKinney (Jour. Washington Acad Sci. 54, 1911, 149), a genus originally differentiated from Marmor as containing viruses not yet inoculable save by tissue union; a natural group of viruses may be represented but their characteristics and affiliations seem not yet clear).

Genus II. Acrogenus Holmes.

(Loc. cit., 110.)

Viruses of the Spindle-Tuber Group, inducing diseases characterized by abnormal growth habit of host plants without chlorotic or necrotic spotting, systemic cihoresis, witches'-broom formation, or production of galls. Generic name from Greek, meaning points or peak-producing, in reference to shape of potatoes affected by potato spindle-tuber virus.

The type species is Acrogenus solani Holmes.

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langsdorffii Weinm.; N. rustica L.; N. tabacum L.

Geographical distribution: United

States (California).

Induced disease: In radish, systemic chlorotic spotting followed by chlorotic mottling of foliage; little or no leaf distortion: plants not stanted.

Transmission: By inoculation of expressed juice No insect vector is known, not by the cabbage aphid, Brevicoryne brassicae (L.); the false cabbage

seeds from diseased radish plants.

Thermal inactivation At 65 to 65° C in 10 minutes.

Literaturo: Tompkins, Jour. Agr. Res., 68, 1939, 119-130.

65. Marmor primulae spec. nov. From New Latin Primula, generic name of primrose.

Common name. Primrose-mosate virus.

Ilosts: PRIMULACEAE—Primula
obconica Hance Experimentally, also
P, malacoides Franch and P, sinensis
Lindl.

Insuscentible species: BEGONIA. CEAE-Begonia semperflorens Link and Otto BORAGINACEAE-Muorotis alpestris Schmidt. CAMPANULA. CEAE-Campanula medium L. CARY-OPHYLLACEAE-Dianthus barbatus CHENOPODIACEAE-Spingera oleracea L COMPOSITAE-Bellis perennia L . Callistephus chinemis Nees. Gerbera jamesonii Hook , Lactuca satira I. Senecio cruentus DC., Tagetes patula L. CRUCIFERAE-Brassica oleracen L. B pe two Buley B. rapa L. , Watthe ola incana R Br., Raphanus satirus L. CI CURBITACEAE-Cucumu saheus I., Cucurbita pepo L EUPHORBIA-CEAE- literaus communit L. GRAM-INEAE-Zea mays 1. LEGUNINO-S.IE - Pisum satirum I. , Vicia faba L , Vigna sinentis (Torper) Sixi LO-BELLIACEAE-Lobelia hybrida Hort. PAPAVERACEAE Paparer orientale sensis L.; Cyclomen indecum L.; Primula currenta L.; P. veris L. RANUNCU. LACEAE—Anemone coronaria L.; Del. phinium cultorum Voss; Ranunculus antateus L. RESEDACAE—Resedo odorata L. ROSACEAE—Geumchiloense Balb. SCROPHULARIACEAE—Antrohimum mapus L., Pentstemon barbatus Nutt., SOLANACIAE—Capsicum frutescens L. Datura stramonium L.; Lycopersicon esculentum Mill.; Nicoliana

PRIMULACEAE-Anagallis ar-

persicon esculentum Mill.; Nicotana glutnosa L.; N tobacum L., Solanum tuberosum L. TROPAEOLACEAE— Tropacolum majus L. UMBELLI-FERAE—Apium gravcolens L. VER-BENACCAE—Verbena hybrida Voss. VIOLACEAE—Viola tricolor L.

Geographical distribution United States (California).

dates (California).
Induced discase, in Primula obconica.

elilorosis, stunting, rugosity with upward, or occasionally downward, upping of leaves. Pettoles and peduneles shortened, flowers reduced in size, broken in color (white-streaked). Leaves coarsely mottled with yellow-green, leaving green islands, tips of leaves sometimes narrowed.

Transmission. By inoculation of expressed twee, in the presence of 600 mesh powdered carborindum. Not by aphids, Mysus preside (Sule.) and M. circumferus (Buckt) (APHIDID.IP.) No insect vector is known. Probably not through seeds.

Thermal inactivation At 50° C, not

48° C, in 10 minutes
Other properties Infective after 21,

not 48, liours in ritro. Infective after 1 10 dilution

Laterature: Tompkins and Middleton, Jour Agr Res , 65, 1911, 671-679

66. Marmor caricae (Condit and Horne) tomb. nov. (Figure caricae Condit and Horne, Phytopath., 51, 1911, 563.) From Lenin carica, a kind of dried for

Common name Fig-mosaic virus.

Hosts: MORACEAE-Ficus carica L.,

ing and rolling of leaves. Foliage leathery. Sometimes conspicuous phloem necessis. Generic name from Latin corium, leather.

The type species is Corium solani Holmes.

# Key to the species of genus Carlum.

- I. Infecting potato.
- II. Infecting beet.
- III. Infecting raspberry.
- Corium solani Holmes. (Handb. Phytopath. Viruses, 1939, 120.) From New Latin Solanum, generic name of potato.

Common name Potato leaf-sol virus. Hosts: SOLA NACEAE—Solanum tuberoum L., potato. Experimentally, also other solanaceous speciea, Datura stramonium L., Jimson weed; Lycopersicon esculentum Mill., tomato; Solanum dulcamara L., bittersweet, S. sullosum.

Insusceptible species: CHENOPODI-ACEAE—Beta vulgaris L., beet.

Geographical distribution: North America, France, British Isles, probably wherever potatoes are grown.

Induced disease In potato, leaves thick, rigid, leathery, and rolled, their starch content excessive. Plants dwarfed. Tubers few, small, crisp. Tubers of some varieties show conspicuous phloem necrosis, germinate with spindling strouts.

Transmission: By aphid, Myeus persicae (Sulz.) (APHIDIDAE), with incubation period of 24 to 48 hours. Also by Myeus cornolicult (Kalt.) (= M pseudosolani Theob.), M. circumficzus (Buckt.), Macrostphum solanifolii Ashm., and Aphis abbreviata Patch (APHIDIDAE). By grafting. Not by inoculation of expressed quice.

Literature Artschwager, Jour. Agr. Res., 16, 1918, 559-570; 24, 1923, 237-245; Dykstra, ibid., 47, 1933, 17-32, Elze, Phytopath., 21, 1931, 675-686, Falsom, Maine Agr. Exp. Sta., Bull. 297, 1921,

- 1. Corium solani.
- 2. Corium betae.
- 3. Corium rubi.
  4. Corium ruborum.

37-52; 410, 1942, 215-250; Murphy, Scient. Proc. Roy. Dublin Soc., 17, 1923, 163-154; Murphy and M'Kay, 1644, 19, 193, 341-353; Schultr and Folsom, Jour. Agr. Res., 21, 1921, 47-50; Smith, Ann. Appl. Biol., 16, 1929, 200-229; 16, 1031, 141-15, Stevenson et al., Am. Potato Jour., 20, 1943, 1-10.

 Corium betae spec. nov. From Latin bela, beet.

Common names: Sugar-beet yellows virus, beet-yellows virus, jaunisse virus, vergelingsziehte virus.

Hosts: CHENOPODIACEAE—Bets vulgaris L., beet, B. maritima L.; B. cicla; Attriplez hortensus L., A. siburea L.; Chenopodum album L., lamb's quarters; Spinacia olerocta L., spinach. AMARANTHACEAE —Amaranthus retroflexus L.

Insusceptible species: SOLANA-CEAE—Solanna, tuberosum L., potato; all other tested solanaceous species

Geographical distribution: Belgium, Netherlands, Denmark, England; perhaps Germany and the United States.

Induced disease: In beet, young leaves little affected; older leaves yellow, buttle, short, thick, containing excessive amounts of carbohydrates; necessis accordary phloem. In spinach, yellowing, necrosis between veins on old leaves

Transmission: Not by inoculation of expressed juice. By aphids, Mysus persicae (Suiz.), Aphis fabac Scop., Macosiphum colanyfolii Ashm., and Aulacor-

### Key to the species of genus Acrogenus.

- I. Infecting potato.
- II. Infecting black current.

 Acrogenus solani Holmes. (Handb. Phytopath. Viruses, 1939, 111.) From New Latin Solanum, generic name of notato.

Common names: Potato spindle-tuber virus, potato spindling-tuber virus, potato marginal leaf-roll virus.

Host: SOLANACEAE-Solanum tuberosum L., potato.

Geographical distribution: United States and Canada.

Induced disease: Plants creet, slift, spindly, lacking vigor. Leaves small, creet, darker green than normal. Peti-oles sometimes slender, brittle. Tubers long, cylindrical, frregular in shape, tap-ored at ends, smooth and tender-skinned, of softer than normal fiesh in spring Feyes of tuber conspicuous.

Transmission: By inoculation of expressed julce, by uso of contaminated knifo in cutting successive tubers before planting; by contacts of freshly cut seed pieces. By aphids, Mysus persicae (Sulz.) and Microsiphum solenjofist Ashm. (= M.gei Koch) (APHIDIDAE). Also by certain leaf-stute insects.

Thermal inactivation: At 60 to 65° C in 10 minutes (in tuber tissues).

Literature: Bald et al., Phytopath., 31, 1914, 181-189; Folsom, Maine Agr. Uvp. Sta, Orono, Bull, 312, 1923, Gov., Phytopath., 16, 1920, 233, 209-303; 18, 1923, 415-418; Nebrasha Agr. Exp. Sta., Res. Bull. 47, 1930, 58, 1931; Jaczewski, La Défense des Plantes, Leningrad., 4, 1927, 62-77 (Rev. Appl. Mycol., 6, 1927, 572-573, Abst.); McLeod, Canad. Exp. Farms, Div. Bot., Rpt. for 193, 1927.

1. Acrogenus solani.

2. Acronemus ribis.

Strains: A strain eausing unmottled curly dwarf of potato has been given a varietal name to distinguish it from the type, var. sulgaris 11. (loc. etc., 111).

la. Acrogenus solani var. severus H. (loc. cit., 112). Indusing symptoms in potato on the whole more severe than those caused by the type strain.

Common name: Unmottled curly dwarf strain of potato spindle-tuber virus. (Goss, Nebruska Agr. Exp. Sta., Res, Bull. 47, 1930, 63, 1931; Schultz and Folsom, Jour Agr. Res. 25, 1923, 43-118.)

Acrogenus ribis II. (loc. cit., 112).
 From Latin ribes, currant.

Common name Black-current reversion-disease virus.

Host · SAXIFRAGACEAE—Ribes nigrum L., European black currant.

Geographical distribution. British Isles.

Induced disease: In European black currant, leaves abnormally narrow and flat, small veins few. Flowers sometimes nearly transparent, smooth, sepals brightly colored beneath. Flowers and small fruits fall. Stems less woody than normal, with tendency to excessive gum production.

Transmission. By grafting. By bigbud mite, Eriophyes ribis (ERIOPHYI-DAE). Not by inoculation of expressed junce. Not through toil. Not through seeds from diseased plants.

Laterature: Amoa and Hatton, Jour. Pom. and Hort. Science, 9, 1929, 167-183; Amos et al., in East Mulling Res. Sta., 15th Ann. Rpt., 1923, 43-46; Lee, Ann. Appl Bod., 9, 1933, 49-68.

Genus III. Cortum Holmes,

(Loc. eit , 119.)

Viruses of the Leaf-Roll Group, inducing diseases usually characterized by thicken-

geniculatus, p.p. of geniculo, knotted, jointed.

Medium-sized rods, occurring singly, in pairs and chains, motile, possessing polar flagella. Gram-negative.

Gelatin colonies: Circular, whitish, transluceat. Deep colonies yellowish.

Gelatin stab: Infundabuliform liquefaction. Sediment light pink.

Agar slant: Grayish, glistening, translucent, limited, becoming brownish-gray. Broth: Turbid, with slight gray pellicle and sediment.

Litmus milk: Alkaline; reduction of

litmus; slight coagulation. Potato: Thin, brownish, moist, glistening, viseid.

Indole not formed.

Nitrites not produced from nitrates. Aerobic, facultative.

Optimum temperature 20° to 25°C.

Habitat: Water.

32. Pseudomonas fragi (Eichholz) Huss emend, Hussong, Long and Hammer. (Bacterium frage Eichholz, Cent. f. Bakt., II Abt., 9, 1902, 425; Huss, Cent. f. Bakt., II Abt., 19, 1907, 661, Hussong, Long and Hammer, Iowa Agr. Exp. Sta. Res. Bull 225, 1937, 122; also see Long and Hammer, Jour. Dairy Sci., 20, 1937, 448) From Latin fragum, strawberry.

Description from Hussong, Long and

Hammer, loc. cit.

Rods 0 5 to 1.0 by 0.75 to 4.0 microns, occurring singly, in pairs and in ebains. Motile with a polar flagellum. Gramnegative.

Gelatin · Grateriform to stratiform liquefaction in 3 to 4 days.

Agar colonies Convey, glistening, generally butyrous, occasionally viscid. Rough, smooth and intermediate forms are recognized in the description quoted. The rough forms are less proteolytic, and less active in the hydrolysis of fats.

Agar slant: Growth abundant, spreading, raised, white, shiny, generally butyrous. Sweet ester-like odor resembling that of the flower of the May apple.

Broth: Turbidity and sediment with a thin pellicle.

Litmus milk: Acid ring followed by ncid coagulum at surface. Complete coagulation in 2 to 3 weeks, some digestion. Characteristic May apple or strawberry odor.

Potato: Growth echinulate to arborescent, raised, glistening, white, becoming brownish.

Indole not produced.

Nitrites not produced from nitrates. Ammonia produced from peptone. Hydrogen sulfide not produced.

Acid from glucose and galactose, sometimes arabinose. No acid from glycerol, inulin, lactose, fructose, maltose, magnitol, raffinose, salicin and

sucrose. No acetylmethylearbinol produced.

Fat is generally hydrolyzed. Acrobic.

Grows from 10° to 30°C. No growth at

37°C. Very sensitive to heat. Source: Isolated from milk and other

dairy products, dairy utensils, water, etc. Habitat: Soil and water. Widely distributed (Morrison and Hammer, Jour.

Dairy Sci., 24, 1941, 9). Hussong (Thesis, Iowa State College,

1932) regards Bacterium fragi Eichholz (loc. cit.) as the R type, Pseudomonas fragariae I Gruber (Geat. f. Bakt., II Abt., 9, 1902, 705) as the O form, and Pseudomonas fragariae II Gruber (Cent. f. Bakt , II Abt., 14, 1905, 122) as the S form of the same organism. He makes no mention of Pseudomonas fragaroidea Huss (loc. cit.) which from its description would belong to the smooth type brief characterization of each of these organisms follows: (1) Bacterium fragi came from milk as drawn from an individual cow; it does not liquely gelatin, exhibits no fluorescence, is strongly alkaline in litmus milk, and does not grow at 37°G, (2) Pseudomonas fragariae I came from fodder beets; it does not liquefy gelatin, has weak blue greenish fluoreseenee, is weakly alkaline in milk, and grows at 37°G, (3) Pseudomonas fragariae II came from pasteurized milk; it liquefies gelatin, coagulates milk, and does not grow at 37°G, (4) Pseudomonas

thum solani Kait. (APHIDIDAE); vrus is not transmitted by these aphids to their descendants. Not through seeds of beet. Virus overwinters in beets stored for subsequent use in seed production.

Serological relationships: Specific precipitating antiserum effective with crude sap of diseased, not healthy, plants and with sap of diseased plants after passags through a Chamberland In, not In, filter candle; ineffective with sap from beet plants suffering from mossic

Thermal inactivation Virus heated to about 52°C no longer precipitates with specific antiserum

Literaturo: Klecakowski and Watson, Ann. Appl Biol. 24, 1941, 104-20, Petherbridge and Stirrup, London, Munstry Agr. and Priberies, Bull. 55, 1935, Quanton and Colondon, Munstry Agr. 1935, 45-70; Roland, 1944, 45, 1930, 1-22, 182-203, Schreven, Meded. Inst. voor Suikerbetenteelt, Bergen op Zoom, 6, 1930, 1; Watson, Proc. Roy. Soc. London, Ser B, 128, 1940, 535-532, Ann. Appl. Biol., 25, 1012, 335-355.

 Corlum rubl If. (loc. cit, 121).
 Irom New Latin Rubus, generic name of raspherry, from Latin rubus, bramble bash

Common name: Raspberry leaf-curl

virus.
11ost ROSACEAE-Rubus idaeus 1...

red rasphorry.

Insusceptible species: ROSACEAE~
Rubus occidentalis 1., black rasphorry,

R. neglectus Peck, purple raspberry.

Geographical distribution: United

States, not in England.

Induced disease: In red raspberry, vens retarded in growth, crusing downward eurling of leaf margins and crinking of leaf lamma. Tolage dark green, dry in appearance, not witting readily. In late summer, leaves bronzed, leaf surface glistening. Diseased cance easily winter-killed Berries small and port. The

English variety Lloyd George is intolerant of the disease and is killed.

Transmission: By aphid, Aphis rubicola Gestl. (= A. rubiphila Patch) (APHIDIDAE). Not by inoculation of expressed juice.

Literature Bennett, Michigan Agr. Evp. Sta, Tech. Bull. 80, 1977; Phytopath., 20, 1930, 787-802; Harris, East Malling Res. Sta., Ann. Rpt. for 1934, 1933, Rankin, New York Agr. Exp. Sta., Geneva, Tech Bull, 178, 1931.

Strains: A strain differing from the type, var. alpha II. (loc. cit., 121), has been given a varietal name derived from its common name, raspberry beta eurl virus.

- 3a Corum rub: var. beta II. (loc. cit., 122). Infecting black and purple mapbernes, as well as the red raspberry, which alone is susceptible to the type strain, raspberry alpha-curl virus. (Bennett, Phytopath., 20, 1930, 787-802.)
- 4 Corlum ruborum (Zeller and Braun) comb nov (Minuor ruborum Zeller and Braun, Phytopath., 33, 1913, 161.) From Latin rubus, bramble bush.

Common name Raspberry decline-dis-

Host ROSACEAE-Rubus idaeus L., red raspherry.

Geographical distribution United States (Orecon)

Induced disease: In Cutibert raspberry, shoots retarded in spring, reddish, leves in autumn rolled downward, fluted along venns, less green than normal between venns, slightly bronzed along marguns and creats between venns. Internodes slustened near tips of ennes. Affected cance small, weak, not hardy in wanter. Small roots and feeder routets fewer than in levelity plants. Disease progressive over about three years. Fruits small, irregular, tending to be glalose, erundly when ripe, worthless.

Transmission: By grafting. No insect

ector is your D.

# Genus IV. Nanus Holmes.

(Loc. cit., 123.)

Viruses of the Dwarf-Disease Group, inducing diseases characterized by dwarfing obst plants or by growth of adventitious shoots with short internodes; chlorete mottling absent. Generic name from Latin acause, dwarf.

The type species is Nanus loganobacci Holmes.

## Key to the species of genus Nanus,

I. Infecting resaceous plants.

A. In loganberry and Phenomenal berry.

1. Nanus loganobacci.

B. In black raspberry.

2. Nanus orientalis.

C. In peach.

3. Nanus mirabilis.

D. In occan spray.

E. In strawberry.

4. Nanus holodisci.

5. Nanus fragariae,
6. Nanus cupuliformans

F. In prune and plum.

7. Nanus pruni.

Infecting graminaceous plants.

A. In sugar cane.

S. Nanus sacchari.

1. Nanus loganobacci Holmes. (Handb. Phytopath. Viruses, 1939, 124.) From New Latin loganobaccus, epecific epithet of loganberry, Rubus loganobaccus Bailey.

Transmission: By aphid, Capilophorus tetrahodus (APHIDIDAE). Not by inoculation of expressed juice. Literature: Zeller, Phytopath., II, 1925, 732 (Abst.); 17, 1927, 629-618.

Common name: Loganberry-dwarf virus.

2. Nanus orientalis H. (loc. cd., 124). From Latin orientalis, eastern. Common names: Raspberry-streak vi-

Hosts. ROSACEAE—Rubus loganobaccus Bailey, loganberry and Phenomenal berry.

rus, raspberry eastern blue-stem virus, raspberry rosette virus. Host · ROSACEAE—Rubus occiden-

Geographical distribution: United States (Oregon, Washington, and California).

Host · ROSACEAE—Rubus because tales L., black raspberry. Insusceptible species: ROSACEAE—

Induced disease In Phenomenal berry, leaves small, obvate, rigid, new canes short, spindly. In young plants, some necrosis along and between veins, leaves crinkled, finer vens chlorotic. Stems not streaked or mottled, normal in color. In late stages, canes very short, internodes short. Sepals and petals of flowers small. Fruit of fair size, but druplets ripen unevenly and tend to fall apart when picked. Loganberry is less sus-

ceptible than the Phenomenal berry but

is similarly affected.

Rubus idaeus L., red raspberry; R. phoencolasius Maxim., Japanese wineberry. Geographical distribution: United States.

Induced disease; In black raspherry, plants stunted, becoming smaller in successive seasons; leaves usually cured, close together on canes, dark green, often twisted so as to be upside down. Ner canes show bluish violet dots, gold, or stripes near their bases and sometimes also on branches or on fruiting spars,

Fruit inferior in size, quality, and quantity. Plants live only 2 or 3 years after infection on the average.

Strains: A strain of this virus is believed responsible for mild streak of black raspberries, in which purple to violet, greenish brown, or bluish streaks on canes are narrowly linear or elliptical in form and often very faint; when the bloom is rubbed off, the lesions appear as though watersoaked and discolored. Leaves are slightly curled, their veins cleared. Fruits are dry and dull in lustre, even while still red, and of poor flavor when rice.

Literature: Bennett, Michigan Agr. Exp. Sta, Tech Bull. 80, 1927, Witcox U. S. Dept. Agr., Dept. Circ. 227, 1923, Woods and Haut, U. S. Dept. Agr., Plant Dis Rut. 24, 1910, 333-340.

3. Nanus mirabilis II. (loc. cit., 126). From Latin mirabilis, strange.

Common name: Peach phony-disease virus.

Hosts. ROSACEAE—Prunus persica (L.) Batsch, peach. Experimentally, also other Prunus species.

Geographical distribution: United States (Georgia, Alabama, Florida; aparsely als in Mussissippi, Tennessee, South Carolina, Louisiana, Texas, Arkansas, Missouri).

Induced disease: In peach, tree dwarfed, folings abnormally green, fruit small, fleeb in wood, especially in roots, sections of roots show characteristic welf-dustributed purples spots after 3 to 5 minutes of treatment in 25ce absolute methyl alcolod acidulated by the addition of 1 to 5 drops of concentrated, chemically pure hydrocklopic acid.

Transmission: By root grafting, except by root-bark patch grafts, which are ineffective. Budding and grafting with parts of star fail to transmis this wire.

of stem fail to transmit this virus.

Thermal insctivation: At 45° Cin about

40 minutes in roots.
Literature: Hutchins, Ceorgia State
Entomol, Bull, 78, 1933; Phytopath., 22,
1939, 12 (Abst.); Hutchins and Rue,
tbid., 29, 1939, 12 (Abst.).

4. Nanus holodiscí H. (loc. cit., 127). From New Latin Holodiscus, generic name of ocean spray.

Common name Ocean-spray witches's broom virus.

Host · ROSACEAE—Holodiscus discolor Max., ocean spray.

Ceographical distribution: United States (Oregon and Washington).

Induced disease In occan-spray, diseased branches form clusters of thin wiry shoots with abnormally short internodes and crowded small leaves. Laterals numerous and more than normally branched. Bronzy red color acquired early by affected follage.

Transmission. By aphid, Aphis spuraces Schout. (APHIDIDAE). By grafting. Not demonstrated by inoculation of expressed unice.

Literature Zeller, Phytopath., 21, 1931, 923-925.

 Nanus fragarfae II. (Holmes, loc. cit., 123; Blastogenus fragariae McKinney, Jour. Washington Acad Scionee, 34, 1944, 151.) From New Latin Fragaria,

generic name of strawberry.

Common name: Strawberry witches's broom virus.

Host: ROSACEAE—Fragaria chiloensis Duch. var. ananassa Bailey, cultivated strawberry.

Ceographical distribution: United States (western Oregon).

Induced disease: In strawberry, leaves numerous, light in color, with spindly pettoles, margins of leaflets bent down, runners sbortened, plants dwarfed; flower stalks spindly and unfruitful; root systems normal and well developed.

Transmission: By aphis, Mysus fragaefolis Ckll. (APHIDIDAE). Not demonstrated by moculation of expressed

juice Literature, Zeller, Phytopath., 17, 1927, 329-335.

6. Nanus expuliforman Zeller and Weaver. (Phytopath., 51, 1911, 851.) From diminutive of Latin cupa, tub, and participal from Latin formare, to form.

name: Strawberry-stunt Common virus.

Host: ROSACEAE-Fragaria chiloensis Duch, var. ananassa Bailey, cultivated strawberry.

distribution: United Geographical States (Oregon, Washington).

Induced disease: In strawberry, little if any reduction in chlorophyll, plants erect but short; leaves at first folded. later open, dull in lustre, with papery rattle when brushed by hand, leaflets cupped or with margins turned down. midveins tortuous; petioles i to i normal length; fruits small, usually hard and seedy; roots normal in appearance.

strawberry-leaf Transmission: By aphid, Capitophorus fragaefolii (APIII-DIDAE). By grafting. Not by inocu-

lation of expressed juice.

7. Nanus pruni II. (loc. cit., 128). From New Latin Prunus, generic name of prune, from Latin prunus, plum tree. Common name . Prune-dwarf virus.

Hosts: ROSACEAE-Prunus domestica L., prune and plum; var. institia Bailey, the Damson plum, remains symptomless. Experimentally, also Prunus persica (L.) Batsch, peach.

Insusceptible species: ROSACEAE-Prunus avium L., cherry. United

Geographical distribution: States (New York); Canada (British Columbia, Ontario).

In prune, leaves Induced disease small, narrow, rugose, distorted, glazed. Internodes short. Some branches escape and appear normal. Blossoms numerous, mature fruits few. Pistils aborted, petals narrow and distorted. In Damson and Bradshaw plums, no obvious manifestations of disease as a result of infection.

Transmission: By budding and other forms of grafting. Not demonstrated by inoculation of expressed juice. No insect vector is known.

Literature: Berkeley, Canada, Domin. Dept. Agr., Div. of Bot. and Plant Path, Science Service, Publ. 679, 1941; Hildebrand, Phytopath., 52, 1942, 741-751; Thomas and Hildebrand, Phytopath., 26, 1936, 1145-1148.

8. Nanus saccharl II. (loc. etf., 129). From New Latin Saccharum, generic name of sugar cane, from Latin saccharum, sugar.

Common name: Sugar-cane serebdisease virus.

Host: GRAMINEAE-Saccharum off cinarum L., sugar cane.

distribution: Geographical Borneo, Sumatra, Moluccas, India, Mauritius, Australia, Fiji, Formosa, Hawaii, Ceylon.

Induced disease: In sugar cane (Cheribon variety), plant dwarfed, shoots stunted, vascular bundles colored by the presence of a red gum; adventitious roots from many or all nodes.

Transmission: Not by inoculation of expressed juice. No insect vector is known.

Thermal inactivation: In cuttings of sugar cane, at 52° C in 30 minutes to 1 hour. Infected cane cuttings survive the heat treatment required for cure through inactivation of the causative virus.

Literature : Houtman, Arch. Suilerind. Nederland. Indie, 55, 1925, 631-612; Lyon, Bull. Exp. Sta. Hawaiian Sugar Planters' Assoc., Bot. Ser., \$, 1921, 1-43; Wilbrink, Arch. Suikerind. Nederland Indië, 31, 1923, 1-15.

Genus V. Rimocortius Malbrath and Zeller.

(Phytopath., 52, 1942, 430.)

Viruses of the Rough-Bark Group, inducing diseases principally affecting bark, less often wood, leaves, or fruit. Generic name from Latin rema, cleft or fissure, and

The type species is Rimocortius kwanzani Milbrath and Zeller. cortex, bark.

(Nors: The genus Citrieir (first named species, Citruir paronis Fawcett, Phytopath., 37, 1941, 357) was proposed by its author as a genus pro tempore with the avowed purpess of accommodating viruses causing diseases in species of the plant-host genus Citrus. It appears to have been implied by the term genus pro tempore that evidences of natural relationship, when discovered, would permit even the first named species of this genus to be assigned elsewhere. On the assumption that a permanent genus is nothing more than a type species and such other species as may be added to it by one or another author, it must be felt that a genus pro tempore, honever convenient as an expedient, cannot become a permanent genus under any circumstances, because its first-named species would appear not to be a permanent part of the genus and so intended not to be a true type-species. Without a type species there would seem to be no permanent genus concept.

The system by which the term Citrier was coined (explained by its author as use of the conitive of the host genus name. Citris, plus rir, signifying vivus) seems in itself acceptable, for it is commonly agreed that a ceneric name may be made in an arbitrary manner. It may be noted that use of the stem of the host-cenus name (Cutr-) with connecting yowel ; and suffix -rir, possibly a more orthodox procedure, would have given the same result in the present instance. The original definition of the term Citruir might be thought to be repugnant as disregarding concepts of natural interspecific relationships that are essential to the spirit of hipomial nomenclature. Were the genus to be regarded as permanent rather than pro tempore, however, the scope of the genus would come to be wholly changed by usage, when, with passage of time related species would be added to what in this case would be a type species, without regard to the unorthodox intent of the original definition but solely in accordance with similarities between viruses. A generic concept need never be accepted as rigidly defined, whether initially, as has been attempted in this case, or upon further experience, because a cerus may still grow by the addition of closely allied new speeles beyond any limit that may be set. On this account an original, or any subsequent. definition may be recarded as subject to unlimited chance so long as the type species is logically retained. The form and definition of the term Citrivir would not, thereforc, militate against its continued use. Its avowedly temporary status alone seems decisively to do so.

The originally monotypic genux Rumcortus, published in the following year, was defined only by the combined generic and specific description, and was not referred to a family by its authors. The type, because at first the only species, Rimcortus kwanzani, is the flowering-cherry rough-back virus. This type species might well be associated with the species Ciferir provense, circus-provess virus, discussed above, both affecting birk principally, though foliage also to some extent. Although the genus Ciferir was named in 1914 and Rimcortus so tuntio 1923, the first was intended as a temporary assemblage only, as above indicated. It would seem appropriate, therefore, to include the virus that was known the temporary as Ciferir provincia in the permanent genus Rimcortus Millerath and Zeller and to assign this genus to the family Marmoraccea.

Key to the species of the genus Rimocortius,

- I Affecting cherry.
- 11. Affecting Citrus.

1 Remocortius Lucanzani.

III. Affecting pear.

Rimacortius psorosis.
 Rimacortius pyri.

1. Rimocortius kwanzani Milbrath and Zeller. (Phytopath., 52, 1942, 430.) From Kwanzan, name of a variety of flowering cherry.

Common name: Flowering cherry

rough-bark virus.

Hosts: Prunus serrulata Lindl. var. Kwanzan, flowering cherry; P. avium L., Mazzard cherry.

Geographical distribution: United

States (Oregon).

Induced disease: In flowering cherry, tree dwarfed, deficient in lateral branches; bark deep brown, roughened, splitting longitudinally; internodes chortened, bunching leaves; leaves areded downward; midribs of leaves split and crached on under surface. In Mazzard cherry, no manifestation of disease, but carrier condition; budded Mazzard stock may transmit disease to healthy Kuanzan cherry clops.

Transmission: By budding, generally even if the inserted bud fails to survive.

Literature: Milbrath and Zeller, Phytopath., 82, 1942, 425-430; Thomas, 101d., 82, 1942, 435-436.

2. Rimocortius psorosis (Fawcett) comb. nov. (Cirver psorosis Fawcett, Phytopath., 51, 1941, 357) Specific name meaning "of the disease known as psorosis."

Common name: Citrus-psorosis virus. Hosts: RUTACEAE—Citrus sinensis Osbeck, orange; C. limonia Osbeck, lemon: C. mazima Merr., grapefruit.

Geographical distribution World-wide where citrus trees are grown.

Induced disease In citrus, small, elongated, light colored areas or flecks in the region of small vens on young, tender foliage, leaves sometimes warped, (chlorotie?) clearing of voins, and chlorotie line patterns, sometimes concentre. Outer layers of bark scale away, depressions and deformities appear in bark and wood. Lemons, as a rule, are more tolerant than oranges and are not subject to the bark changes.

Transmission: By grafting, including root grafting and patch bark grafting. Not by inoculation of expressed juice. No insect vector is known.

Literature: Bitancourt et al., Phytopath., 25, 1913, 865-833; Fawcett, fbd., 24, 1934, 695-665; Science, 28, 1910, 50-561; Phytopath., 31, 1911, 356-337; Famcett and Bitancourt, bid., 35, 1913, 837-854; Bhoads, bid., 28, 1912, 416-413; Webber and Fawcett, Hilgardia, 9, 1935, 71-102.

Strains: Three strains differing from the type have been recognized. The type, var. vulgare Fawertt, Phytopath, 51, 1941, 357, causes psorosis A, the common scaly-bark type of disease, with pastular exquitions of outer layers of bark in limited areas, with or without exudation of gum; later a drab-gray, clanamondrab to rules discolonation of the wood, accompanied by decline of the affected tree. Others, that contrast with the type, are:

- 22. Rimocorfius protests var, anulatum Fawcett. (Phytopath., 31, 1941, 357.) From Latin anulatus, with a ring. Causing peroress B, known from Calibrais, resembling zonate chloresis of Bratil in effects on leaves and Irails. Peroreis B is characterized by rapid eading of outer bark in continuous areas, progressing rapidly along one side of trunk or branch; gume cutdes in advance of scaling, necrosis follows; large circular discolored and corky spots, sometimes concentric, on fruits and mature leaves; on some fruits, circular or semi-circular furrows and humps; rapid decline of the affected free.
- 2b. Rimocortius prorosis var. concurm Fawcett and Bitancourt. (Phytopath., \$5, 1943, \$30.) From Lain concave, concave. Causing concave-gum promisis, characterized by concavities of various sures on trunks and larger limbs of affected trees, often by zonate patterns on young leaves during periods of rapid growth.

Cc. Rimocortius psorosis var. alrealum Fawcett and Bitancourt. (Phytomath . 33 1013 851.) From Latin alreafus, hollowed out like a trough. Causing blindpocket psorosis, characterized by troughlike pockets in bark and wood or by cruptive lesions.

3. Rimocortius pvrl (Holmes) comb. nov. (Marmor pyri Holmes, Handb. Phytopath. Viruses, 1939, 76 ) From New Latin Purus, generic name of pear, from Latin pirus, bear tree.

Common name: Pear stony pit virus. Host : ROSACEAE-Purus communis L. pear.

Geographical distribution: United States (Oregon, Washington, California).

Induced disease: In pear, fruit deeply putted and deformed; bark cracked and resembling oak bark; yearlet chlorosis of some leaves, failure of lateral buds to grow, reduction of foliage Bartlett and Comice varieties of pear appear to be tolerant, producing sound fruit from injected trees.

Transmission. By budding. Not by inoculation of expressed juice. No insect vector is known.

Literature . Kienholz, Phytopath., 29, 1939, 260-267, 30, 1940, 787 (Abst.).

## Genus VI. Adelonosus Brierley and Smith

(Phytopath., 34, 1944, &51.)

Viruses capable of multiplying in living plants but producing no recognizable symp toms in these except on interaction with distinct viruses with which they form com-Transmitted by aphids, by sap, or by both means Generic name from Greek adelos. Invisible, and nosos, disease. Only one species is recognized thus far; this is the type species. Adelenosus like Brierley and Smith.

1. Adelonosus IIII Brierley and Smith (Phytopath., \$4, 1911, 551.) From Latin lilium, lily

Common name: Lily-symptomicss wirtin.

Host : LILIACEAE-Lilium longiflorum Thunb., Laster lily.

Insuscentible species. All other tested libes and many related plants in the same and other families (for list, see Phyto-

path., 34, 1914, 519). Geographical distribution. United States, Japan: probably coextensive with commercial culture of Laster fily.

Induced disease: In Easter lily, no obvious manifestation of disease when this virus is present alone; when together with encumber-mosaic virus, however, the blasymptomics virus is a determining factor in the production of necrotic-fleck disease; the lily-symptomless virus is so nidely distributed in sunposedly healthy stocks of the Paster bly that cucumber mosaic virus formerly was thought to be the sole determining factor in pecrotic flecking, now recognized to be caused by the virus complex lilysymptomicsa virus (Addionosus lilis) plus cucumber-mosaic virus (Marmor cucumeres), the complex acts independently of the presence or absence of hily latent. mosaic virus (Marmor mite), which is often present with the essential members of the complex in flecked Laster Idies.

Transmission By inoculation of expressed ruice, with some difficulty. By aphid, Aphis gossypu Glov., cotton aphid (APHIDID.IE); preintective period after obtaining virus, 4 to 6 days.

## FAMILY III. ANNULACEAE HOLMES.

(Handb. Phytopath. Viruses, 1939, 97.)

Viruses of the Ringspot Group, causing diseases usually characterized by acrots or chlorotic spotting with concentric-ring lesions and eventual recovery from obvious disease with non-sterile immunity. Hosts, higher plants; vectors unknown. There is a single genus.

### Genus I. Annulus Holmes.

(Loc. cit., 97.)

Characters those of the family. Generic name from Latin annulus, a ring. The type species is Annulus tabaci Holmes.

## Key to the species of genus Annulus.

- I. Found occurring naturally in the Western Hemisphere.
  - A. In tobacco.

- 1. Annulus tabaci.
- 2. Annulus zonatus.
- 3. Annulus orae.
  4. Annulus aperius.
- B. In potato.
- C. In delphinium.
- C. In despaimum.
- 11. Old World species.
- 1. Annulus tabaci Holmes. (Handb. Phytopath. Virusea, 1939, 98, Marmor anularium McKinney, Jour. Washington Acad. Sci., 54, 1944, 327.) From New Latin Tabacum, early generic name for tabusco.

Common names: Tobacco-ringspot virus, green ringspot virus, yellow ringspot virus, ring spot No. 1 virus.

SOLANACEAE-Nicotiana Hosts tabacum L., Petunia violacea Lindl., Solanum tuberosum L. CUCURBITA-CEAE-Cucumis salicus L. Experimentally this virus has been found capable of infecting many species of plants in a large number of families; these include all tested species of the SOLANACEAE, SCROPHULARIACEAE, COMPOSIand CUCURBITACEAE. TAE. Many species of the LEGUMINOSAE are susceptible and one, Vigna sinensis (L.) Endl., is used as an indicator plant for quantitative measurement because it displays conspicuous reddish-brown necrotic lesions around points of imital infection.

- 5. Annulus dubius.
- 6. Annulus delphinii.
- 7. Annulus bergerac.

Geographical distribution: United

Induced disease: In tolacco, nerolic ring like primary lesions, followed by secondary necrotic rings on younger leaves. Subsequently, affected plants recover. After recovery from obload disease, virus content of plants is only 10 to 20 per cent of that of recently inserted plants. Some varieties may show mosaic-luke patterns in young leaves

at 16°C.

Transmission: By inoculation of evdressed juices. Through about 20 per
cent of seeds from diseased petunia
plants. Not by dodder, Cuscula campesplants. Yuncker (CONVOLVULACEAE).

Serological relationships: Induces the formation of specific precipitating antibodies when injected into bloodstream of rabbat.

rabbit.
Immunological relationships: Recovered tobacco plants are not succeptible to reinfection with the virus but are readificated with Annulus zonatus or A. oras. This virus produces primary lesions on

leaves of plants immune to reinfection with A. bergerac.

Thermal inactivation: At 68° C in 10 minutes.

Filterability: Passes V, N, and perhaps W Berkefeld filters.

Other properties: Particle size estimated by filtration experiments as about 19 millimicrons. Sedimentation constant, S<sub>8</sub>° = 115 × 10<sup>-14</sup> em, eec. <sup>-1</sup> dync". Infective in dilutions of 10<sup>-2</sup> after purification. Inactivated in 1 hour below pill 3 or above pil 10.8. Recovered plants of tobacco contain 0 002 mg of virus per gram, recently infected plants about 6 times as much Optimum conditions for retaining infectivity of stored virus include suspension in 0.01 M phosphate buffer at pill 7 and storage at 4° C.

Literature Fenne, Phytopath . 21. 1931, 891-899; Fromme et al., 161d, 17, 1927, 321-328; Henderson, thid . 21, 1931. 225-229, Henderson and Wingard, Jour. Agr. Res , 43, 1931, 191-207, Price, Contrib. Boyce Thompson Inst., 4, 1932, 359-403. Phytopath., 26, 1936, 503-529. Am. Jour Bot., 27, 1910, 530-511, Am. Naturalist, 74, 1910, 117-128; Priode, Am. Jour. Bot . 15, 1928, 88-93 . Stapley, Jour. Biol. Chem , 129, 1939, 405-428, 429-436, Stanley and Wyckoff, Science, 85, 1937. 181-183, Valleau, Kentucky Agr Exp. Sta , Huli, 327, 1932; Wingard, Jour, Agr. Res., 37, 1929, 127-153; Woods, Contrib. Boyce Thompson Inst , 5, 1933, 419-431.

Strains A number of distinctive strains have been collected in nature and studied experimentally. The following have been given varietal names to distinguish them from the type, var. rirginicians II., loc. cit., 98:

Ia. Annulus tobact var. Lentuckarnus H. (toc. etc., 993). Differing from the typical strain in producing less necessis and less stunting in tobacco. (Price, Phytopath., 25, 1936, 665-675; Valleau, Kentucky Agr. Evp. Sta., Bull. 327, (932.)

1b. Annulus tahacs var. auratus 11. (lec. cit., 100). Secondary lesions in tobacco at first yellow spots or rings, becoming necroits subsequently. Recovery less complete than with type, abnormal yellowing of old leaves tending to persist. (Chester, Phytopath., 28, 1935, 658-701, Price, Phytopath., 28, 1936, 656-765, Valleau, Kentucky Agr. Exp. Sta., Bull 327, 1992, Phytopath., 29, 1933, 549-551.

Annulus zonatus II. (loc. cit., 101).
 From Latin zonatus, zonate.

Common names. Tomato-ringspot virus, ring spot No. 2 virus.

Hosts: SOLANACEAE—Nicotiana tabacum L, tobacco. Experimentally this virus has been found to infect many species of plants in a large number of families.

Geographical distribution: United States.

Induced disease. In tobacco, zonate necrotic primary lesions and, tempororily, secondary lesions of the same type; recovery with specific, non-sterile immunity. In tomato, systemic infection, yellowish-green or necrotic ring-like lesions, stunting.

Transmission. By inneulation of ex-

immunological relationships. Recovered plants are immune to reinfection but are still susceptible to Annalus labaci, A. bergerae, and several mosaic-type viruses that have been tested.

Thermal inactivation At 55 to 60° C in 10 minutes Filterability Passes Gradocol mem-

brane 100 millimicrons in average pore diameter. Particle size estimated as 50 millimicrons or less.

Literature Price, Phytopath., 26, 1936 665-675, Am. Jour. Bot., 27, 1940, 530-541.

3 Annulus orse H. (Holmes, loc. etc., 103, Tractus orae Valleau, Phytopath., 50, 1940, 820.) Trom Latin ora, edge, in reference to occurrence of induced discusses near edge of telegoop fields.

Common name: Tobacco-streak virus.

Hosts. NOLAVACEAE-Nicotiana
tobacum L., tobacco. Experimentally, a

number of other solanaceous plants have been reported as susceptible, but not Capsicum frutescens L., pepper; Lycopersicon esculentum Mill., tomato; Solonum melongena L., eggplant; or S. tuberosum L., potato.

Geographical distribution: United

States.

Induced disease In tobacco, local and systemic necrosis in 3 days, with irregular spot, line, and ring-like lesions, followed by recovery from necrotic manifestations of disease. Recovered leaves may show a mild mottling and regularly contain virus; reinoculation does not induce formation of necrotic lesions in them.

Transmission: By inoculation of expressed juice. Not through seeds from diseased plants.

Immunological relationships No crossprotection with respect to A. tabaci, and several viruses of the mosaic group.

Thermal mactivation: At 53° C in 10 minutes.

Literature Johnson, Phytopath., 26, 1936, 285-292; Trans. Wisconsin Acad. Sciences, Arts and Letters, 30, 1937, 27-34.

4. Annulus apertus spec. nov. From Latin apertus, frank.

Common name: Broad-ringspot virus. Hosts: SOLANACEAE—Nicotiana tabacum L., tobacco. Experimentally also to many species in this and other families.

Insusceptible species: CHENOPODI-ACEAE—Beta vulgaris L. CUCURBI-TACEAE—Citrullus vulgaris Schrad. LEGUMI NOSAE—Medicago satua L., Melilotus alba Desr.

Geographical distribution: United States (Wisconsin).

Induced disease In tobacco, indistinct yellow-spot primary lesions, becoming chlorotte or necrotic rings with concentric markings; small chlorotte rings, sometimes concentric, or fine brown necrotic rings as secondary lesions; young leaves puckered at first, somewhat multormed.

Transmission: By inoculation of expressed juice,

Immunological relationships: Protects against reinfection with homologous virus but leaves host susceptible to infection by Annulus tabaci, A. zonatus, and some mosaic-type viruses.

Literature: Johnson and Fulton, Phytopath., S2, 1942, 605-612.

5. Annulus dubius (Holmes) comb.nov. (Marmor dubium H., loc. cit., 42.) From Latin dubius, uncertain, in reference to a common name, potato virus X, often used to designate this virus.

Common name: Potato-mottle virus (strains of this virus have been studied at various times under the names potato latent virus, potato virus X, potato-aneerosis virus, virulent latent virus, simple moeaic virus, healthy potato virus, Hyoscyamus IV virus, Petalent streak virus, potato foliar-necrosis virus, potato aeronecrotic streak virus, Up-to-Date streak virus, potato viruses B and D, Solaum viruses 1.4 and D,

Hosts: SOLANACEAE—Solanum tuberosum L., potato; Lycopersiem etwlentum Mill., tomato. Experimentally, sles
SOLANACEAE—Capitum frutarea
L., pepper; Datura stramonium L. Jimson weed; Hyacsyamus niger L., henhan;
Nicotuana tabacum L., tohaco; Phyalis
olk-kengr L.; Solanum dulcamara L, biltersweet; S. nigrum L., black nightshade.
AMARANTHACEAE—Amarachia
retroficzus L. COMPOSITAE—Chrysathenium morifolium Ram. SCROPHILARIAGEAE—Tironica sp., common
speedwell.

Geographical datribution: Widespread throughout the world; present in all known stocks of tubers of some polsto varieties in the United States.

Induced discove: In potato, usually no chlorotic mottling, sometimes a little; intracellular inclusions of the vacuolate, granular type; some varieties that are virtually immune in the field owe their tendency to localize the virus in necrolic primary lesions or in top-necrosis of first systemically infected plants to a dom-

fragaroidea came from butter; it liquefies gelatin, coagulates milk, and grows at 37°C.

\*33. Pseudomonas nebulosa (Wright) Chester. (Bacillus nebulosus Wright, Memoirs Nat. Acad. Sci., 7, 1893, 465; Chester, Man. Determ. Bact., 1901, 311; Achromobacter nebulosum Bergey et al., Manual, 1st ed., 1923, 145; not Bacillus nebulosus Hallé, Thèse de Paris, 1893; not Bacillus nebulosus Vincent, Ana. Inst. Past., 21, 1907, 59; not Bacillus nebulosus Migula, Syst. d. Bakt., 2, 1900, 844; not Bacillus nebulosus Goresine, Jour. Bact., 27, 1934, 52.) From Latin. nebulo. mist.

Medium-sized rods, occurring singly Motile, possessing polar flagella. Gramnegative.

Gelatin colonies: Thin, circular, gray, translucent, hazy, with white center

Gelatin stab: Crateriform liquefaction Agar slant: Thin, transparent streak. Broth: Turbid, with gray sediment. Litmus milk: Alkaline; reduction of litmus.

Potato: Scanty growth.

Indole not formed.

Nitrates not produced from nitrates.

Sugar gelatin in deep stab . Fair growth, with some gas formation.

Aerobic, facultative.

Optimum temperature 30° to 35°C Habitat: Water.

Probable synonym: Pseudomonas centrifugans Chester. (Man. Determ Bact., 1901, 312; Bacillus centrifugans Wright, Mem. Nat. Acad. Sci., 7, 1895, 462.)

34. Pseudomonas coadunata (Wright) Chester. (Boeillus coadunatus Wright, Memoirs Nat. Acad. Sci., 7, 1893, 469) Chester, Man. Determ. Eact., 1901, 310; Achromobacter coadunatum Bergey et al., Manual, 1923, 147.) 1st ed., From Latin, coadunatus, to unite closely. Medinm-sized rods, with rounded ends, occurring singly, in pairs and in chains. Mottle, possessing a polar flagellum. Gram-negative.

Gelatin colonies: Circular, brownish, dense.

Gelatin stab : Crateriform to stratiform liquefaction.

Agar slant: Gray, translucent,

Broth: Turbid, with gray pellicle and sediment. The medium has a slight greenish tint.

Litmus milk: Acid; coagulated. Indole is formed.

Nitrites not produced from nitrates, Sugar gelatin in deep stab: Good growth of discreet and confluent whitish colonies, Marked gas production; no liquefaction.

Acrobic, facultative.

Optimum temperature 20° to 25°C.

Habitat: Water.

35 Pseudomonas multistriata (Wright) Chester. (Bacillus multistriatus Wright, Memoirs, Nat. Acad. Sci., 7, 1855, 462; Chester, Man Determ. Bact, 1901, 310; Achromobacter multistriatum Bergey et al, Manual, lat ed, 1923, 147) From Latin, multus, many, much; stratus, grooved.

Medium-sized rods, with rounded ends, occurring singly and in pairs. Motile, possessing polar flagella. Gram-negative. Gelatin colonies: Circular, grayish-

white, translucent.
Gelatin stab Crateriform liquefaction.

Agar slant: Narrow, translucent, grayish streak.

Broth: Turbid.

Litmus milk: Slightly acid; coagulated. Potato. Grayish to creamy, thick, glistening, viscid, spreading.

Indole not formed.

Nitrites not produced from nitrates. Sugar gelatin in deep stab: Vigorous growth with marked gas production; also liquefaction.

<sup>\*</sup>Prof. E. R. Ilitchner, Univ. of Maine, Orono, Maine assisted in rearranging the descriptions of the acid and gas producing pseudomonads (Aeromonas), April, 1913

anisotropy of flow. Destroyed by drving. Inactivated by papaine and cyanide, but by neither separately. Digested by 002 per cent solution of pensin in 3 hours at pH 4, at 38° C. Digested also by trypsin. About 6 per cent of the purified virus is reported to be a pentose nucleic acid, but the carbohydrate to phosphorus ratio is about twice that for yeast nucleic acid. Guanine and pentose present. Analysis of sedimented virus, carbon 47.7 to 49.5 per cent, hydrogen 6.8 to 7.7 per cent, nitrogen 14.6 to 17.0 per cent, phosphorus 0.4 to 0.7 per cent, sulfur 1.1 per cent, carbohydrate 2.5 to 4.3 per cent, ash 2.0 to 2.5 per cent. Reduction of carbohydrate content of sample to 2.5 per cent does not reduce activity of virus; further reduction inactivates. (Ainsworth. Ann. Appl. Biol., 21, 1934, 581-587, Bawden, Brit. Jour. Exp. Path., 16, 1935. 435-443; Bawden and Pirie, bid., 19, 1938, 66-82, Birkeland, Bot, Caz., 95, 1934, 419-436; Chester, Phytopath., 26, 1936, 778-785; Johnson, Wisconsin Agr. Exp. Sta., Res. Bull. 76, 1927; Loring, Jour, Biol. Chem., 126, 1938, 455-478; Loring and Wyckoff, 1bid., 121, 1937, 225-230.)

5b. Annulus dubius var. flavus II. (loc. cit., 46). From Latin flavus, yellow. Common name: Yellow-mottle strain of potato-mottle virus. Differing from the type by imparting a yellow east to foliage of infected potatoes. (Putnam, Canad. Jour. Res., Sec. C, 15, 1937, 87-107.)

5c. Annulus dubius var. obscurus H. (loc. et., 46). From Latin obscurus, obscure. Common name. Masked-mottle strain of potato-mottle virus. Differing from the type by systemically infecting potato, tobacco, and Jimson weed without symptoms under ordinary experimental conditions; in pepper, however, systemic necrosis is induced, as by all known strain. (Chester, Phytopath., 25, 1936, 778-785.)

 Annulus delphinii spec. nov. From New Latin Delphinium, generic name of host.

Common names: Delphinium-ringspot virus, perennial-delphinium ringspot virus.

Hosts: RANUNCULACEAE—Delphinium sp., perennial delphiniums. Experimentally, also to CHENOPPDI-ACEAE—Beta vulgaris L. CUCUR-BITACEAE—Cucumis sativus L., cucumber. MALVACEAE—Gassipium hirsutum L. RANUNCULACEAE—Ranunculus ansaticus L. (symptomless carrier). SOLANACEAE—Datura stramonium L., Nicotiana alata Link and Otto, N. glutinosa L., N. rustica L., N. tobacum L., Petunfa hybrida Vilm,

Geographical distribution: United States (California).

Induced disease: In perennial delphiniums, faint chloretic rings with green or yellow centers on young leaves, irregular chlorotic spots, yellow bands, or irregular chlorotic rings on mature leaves.

Transmission: By inoculation of expressed juice in the presence of factly powdered carborundum.

Thermal inactivation: At 65° C in 10 minutes.

Literature · Severin and Dickson, Hilgardia, 14, 1942, 465-490.

7. Annulus bergerac H. (loc. cit, 102).
From Bergerac, a town in southwest
France.
Common pages Bergerac ringspot

Common name, Bergerac-ringspot

Hosts: SOLANACEAE—Nicotiana tabacum L., tobacco. Experimentally, this wirus has been transferred to several other solanaceous plants and to Phascolus valgars L., bean, in the family LEGUM-INOSAE.

Geographical distribution: France.
Induced disease: In tobacco, thin
necrotic-ring primary lesions, followed by

inant allele of a gene mz, which characterizes plants abowing a mosale of some degree of intensity on infection with this virus; the variety known as \$1956 is immune to all tested strains of the virus and possesses two dominant genes both required for resistance. In tomate, systemic mild chlorotic mottling; if a strain of tobacco-mosale virus is also present, a severe systemic necrosis, known as double-virus streak, is induced.

Transmission: By inoculation of expressed juice. Experimentally, by leaf contacts mainly under the influence of wind. No insect vector is known. Not transmitted through true acceds of the potato.

Serological relationships: Gross precipitin reactions between constituent strains of this virus. No cross reaction with potato aucuba-mossic, potato mild-mossic, potato mild-mossic, tobacco-etch, tobacco-ringspot or pea mossic virus. Antirear prepared by injecting rabbuts intravenously with virus innetivated by nitrous acid, like those prepared with active virus, fix complement and flocculate with virus auspensions (though not with juice of healthy host plants), they are also effective in neutralizing the virus.

Immunological relationships: Tobroco and Dature plants infected by the type strain of this virus become immune to the more evere potato-ringipot strain. No protection against the severe at run is afforded by previous infection with to-lacco-mosaic, obsecc-ingropt, consist opotted-will, or eucumber-mosaic sures. Thermal insertivation: At 70° C in 10

minutes
Filterability Passes Pasteur-Chamberland L., L., and L. filters.

Other properties: Digested by 0 02 per cent solution of pepsin in 3 hours at pII 4, at 35° C. Digested also by trypsin, Instituated by papsing and symiles, but by neither separately. Societies point near pII 4. Dilute solutions show anisotropy of flow Concentrated solutions are strontaneously birefingent. Propersize properties of the properties of the pro-

ties of the type strain have been less

studied than those of the potato-ringsnot strain of this virus.

Literature: Bawden, Proc. Rov. Soc. London, Ser. B, 116, 1934, 375-395; Bawden and Piric, Brit, Jour, Exp. Path., 17. 1936, 64-74; Banden et al., sbid., 17, 1936. 201-207; Blodgett, Phytopath., 17, 1927, 775-782. Böhme, Phytopath, Ztschr., 6. 1933, 517-524, Cadman, Jour, Genetics, 44, 1942, 23-52; Chester, Phytonath., 27, 1937, 903-912; Clinch, Sci. Proc. Roy. Dublin Soc., £3, 1942, 18-31; Johnson, Wisconsin Agr. Exp. Sta., Res. Bull. 63, 1925, Koch, Phytopath , 25, 1933, 319-342, Köhler, Phytopath. Ztschr., 5, 1933, 567-591; 7. 1931, I-30; Loughnane and Murphy, Nature, 141, 1938, 120; van der Meer, Cent. f. Bakt., If Abt., 87, 1932. 210-262; Salaman, Nature, 151, 1933, 463; Schultz et al., Phytopath., 27, 1937, 190-197: 30. 1910, 911 951, Spooner and Bawden. Brit, Jour Exp. Path., 16, 1935. 218-230, Stevenson et al., Phytonath., 29, 1939, 362-365,

Strains: Several variants of potatomottle virus, differing from the type, var, rulgers II. (loc. cit., 42), have been recognized as distinctive varieties under the following names:

Sa. Annulus dubius var. unnulus II. (loc. cit., 41). From Latin unnulus, ring.

Common name: Rangapot strain of potato-mottle virus. Necrotic primary and secondary ring-like lesions in experimentally infected tobacco plants. Indistinguishable from type strain by ordinary precipitin test, but distinguishable when appropriately absorbed sera are used. This strain has been more frequently studied than the type. Juice of infected tobacco plants contains about 0.02 to 0.10 mg of varus per ml. Sedimentation constants, Su. = 113 × 10-11 and 131 × 10-13 cm. sec. -1 dyne-1. Dissymmetry constant 2.78. Molecular weight 26 X 10s. Particle size estimated to be 433 by 9.5 millimicrous, 43.9 times as long as wale. Isoelectric point near plf 4, Stable between pll 4 and pll 9.5. Concentrate l solutions are apontaneously birefringent. Dilute solutions

# FAMILY IV. RUGACEAE HOLMES.

(Handb. Phytopath. Viruses, 1939, 114)

Viruses of the Leaf-Curl Group, causing diseases characterized by auddenly arrested development of invaded tissues, resulting in leaf curl, enations, and other deformities. Vectors, typically white-flies (ALEYRODIDAE). There is a single genus.

# Genus I. Ruga Holmes.

(Loc. cit., 114.)

Characters those of the family. Generic name from Latin ruga, a wrinkle. The type species is Ruga tabaci Holmes.

# Key to the species of genus Ruga.

- I. Infecting tobacco.
- II. Infecting cotton.
- III. Infecting cassava (Manihot).
- IV. Infecting sugar-beet.
- 1. Ruga tabaci Holmes. (Handb. Phytopath. Viruses, 1930, 115.) From New Latin Tabacum, former generic name of tobacco.

Common names: Tobacco leaf-curl virus, kroepoek virus, curl-disease virus, crinkle-disease virus.

Hosts: SOLANACEAE—Necotiona tabacum L., tobacco. COMPOSITAE—Vernonia bodocalys, V. cineria, Ageratum conyzoides L., Synedrella nodiflora Gaertin. Experimentally, also other sofinanceous plants.

Insusceptible species · MALVACEAE

-Gossypium hirsulum L, cotton.

Geographical distribution: Tanganyika, Southern Rhodesia, Southern Nigeria, Nyasaland, India, Sumatra, Formesa.

Induced disease: In tobacco, leaves curled and crinkled, with occasional leafy outgrowths or enations. Voins greened and thickened. No oblorosis nor necrosis. Plant stunted.

Transmission. By white-fly, Bemisia yossypiperda Misra and Lamba (ALEY-RODIDAE). By grafting. Not by inoculation of expressed juice.

Literature: Kerling, Phytopath., 25, 1933, 175-190; Mathur, Indian Jour. Agr.

- 1. Ruga tadaci.
- 2. Ruga gossypii.
- 3. Ruga bemisiae.
- 4. Ruga terrucosans.
- Sci., 5, 1933, 89-96; Matsumoto and Tateolo, Trans. Nat. Hist. Soc. Formess, 50, 1940, 31-33; Pal and Tandon, Indian Jour. Agr. Sci., 7, 1937, 363-393; Pruthi and Samuel, ibid., 7, 1937, 659-670; Storey, Nature, 128, 1931, 187-185; East African Agr. Jour., 1, 1935, 148-153; Thung, Meded. Proefsta, Vorsteal. Tabak Java, 72, 1932, 78, 1934.
- 2. Ruga gossypil H. (loc. cit., 116). From Latin gossypium, cotton,

Common names: Cotton leaf-curl virus, cotton leaf-crinkle virus.

Hosts: MALVACEAE-Gossypium

Althaea rosea Cav., hollyhock; Sakel (hybrid) cotton.

(hybrid) cotton.

Geographical distribution: The Sudan and Nigeria, in Africa.

Induced disease: In cotton, clearing of veins, blistering and pale spotting of leaves; leaves puckered at edge and unsymmetrical. Internodes shortened, producing bunchy growth.

Transmission: By white fly, Bemisia gossypiperda Misra and Lamba (ALEY-

systemic mottling with some chlorotic rings on the dark green islands. Later, complete recovery occurs, with non-

sterile immunity.

Transmission: By moculation of expressed juice.
Immunological relationships: Recovered plants are susceptible to infection by Annulus tabaci and A. zonatus. Thermal inactivation: At 80° C in 10

minutes.

Literature: Smith, A textbook of plant virus diseases, P. Blaliston's Son and Co., Inc., Philadelphia, 1937, 285-289.

the end of the season, showing puckering and downward curling of leaves at the top of the plant, reduction in size of new leaves, and shortened internodes, or they may gradually become chlorotic and die.

Transmission: By leafhopper, Eutettie tenellus (Baker) (GICADELLIDAE) with 4 to 12 hour preinfective period. Through dodder, Cuscuta campestris Yuncker (CONVOLV ULACEAE). Not, with any regularity at least, by mechanical inoculation of expressed juice. Not through seeds of discased plants to seed-through seeds of discased plants to seed through seeds of discased plants to seed through seeds of discased plants to seed through seeds of the leaf through the seed of the leaf through the seed of the leaf through the seed of the leaf through through the leaf through through the leaf through through the leaf through the leaf through the leaf through the leaf through through the leaf through through the leaf through the leaf through through the leaf through through the leaf through th

Thermal inactivation · At 75° to 80° C in 10 minutes.

Filternbility: Passes Berkefeld V, N, and W, Mandler medium and fine, and Chamberland La, Li, La, La, La, La, Lu and Lus filters.

Other properties: Withstands alcohol and acetome treatments. A pH of 2.0 or lower inactivates, but an alkaline reaction as high as pH 0.1 does not inactivate, in 2 hours. Virus active after at least 8 years in tssues of thoroughly dried young

sugar-beet plants, 6 months in dried leafhoppers, and 10 months in dried phloem exudate.

Strains: In general it has proved possible to modify strains by host passage, some hosts like Chenopodum murde L. appearing to select less virulent strains, others like Stellaria media (L.) Cyrine, reversing this selection and restoring virulence.

Literature: Bennett, Jour. Agr. Res., 48, 1934, 665-701; 50, 1935, 211-241; 56, 1938, 31-52; Phytopath., 52, 1942, 826-827; Carsner, Phytopath., 15, 1925, 745-757; U. S. Dent. Agr., Tech. Bull. 360, 1933; Jour. Agr. Res., 55, 1926, 345-318; Dana, Phytopath., 28, 1938, 649-656; Fawcett, Revista Industrial y Agricola de Tucumán, 16, 1925, 39-46; Fife, Phytopath., 30, 1940, 433-437; Giddings, Phytopath., 27, 1937, 773-779; Jour. Agr. Res., 56. 1938, 883-894; Lackey, Jour. Agr. Res., 55, 1937, 453-460; Lesley and Wallace, Phytopath., 28, 1938, 548-553; Murphy, 151d., 50, 1940, 779-781; Severin, Hilgardia, 3, 1929, 595-636; Severin and Freitag, 1bid., 8, 1933, 1-48, Severin and Henderson, Hilgardia, 5, 1928, 339-393; Severin and Swezy, Phytopath., 18, 1928, 681-690; Shaw, U. S. Dept. Agr., Bull. 181, 1910.

RODIDAE). Not through egg of insect vector. Not by inoculation of expressed juice. Not through soil. Not through seeds from diseased plants.

Literature: Bailey, Empire Cotton Growing Rev., 11, 1934, 280; Kirkpatrick, Bull. Entom. Res., 21, 1930, 127-137; 22,

1931, 323-363,

3. Ruga bemisiae H. (Holmes, loc. cit., 117; Ochrosticta bemisiae McKinney, Jour. Washington Acad. Sci., 34, 1943, 149.) From New Latin Bemisia, generic name of insect vector.

Common names : Cassava-mosaie virus,

Hoste: EUPHORBIACEAE-Manihot utilissima Pohl, cassava; M. palmata

Muell., M. dulcis.
Geographical distribution: Gold Coast,
Belgian Congo, French Camercons, Rho-

Belgian Congo, French Camercons, Rhodesia, Liberia, Madagascar, probably throughout Africa and adjacent islands; Java.

Induced disease: In Manihot utilissima, leases unsymmetrical, curled, distorted, mottled, internodes shortened, plants stunted. Axillary buds produce an extra number of side branches.

Transmission. By white-flies (ALEY-RODIDAE), Remusa angeriensis Corh., in Southern Nigeria, and B., gossyriperda Misra and Lamba, in Belgian Congo and Transmyrka. White-flies infect only young leaves. Not by needle-puncture, rubbing, or hypodermic-needle injection of time expressed from diseased plants.

Intertuire Dade, Yearbis, Dept, Agr Gold Ceast, 1930, 215; Duffenoy and Hedin, Rev. Bot. Appl., 9, 1929, 361-365; Golding, Trop. Agric., Trinidad, 15, 1930, 182-185, Rufferath and Glesquiker, Compt. rend. Soc. Biol. Refgs, 109, 1932, 1140, Lefevre, Bull. Agr. Congo Belge, 26, 1935, 442, McKinney, Jour. Agr. Res., 29, 1935, 442, McKinney, Jour. Agr. Res., 29, 1920, 557-578; Muller, Bull. Inst. Planteniekt., 24, 1931, 1-17; Pascalet, Agron Colon, 21, 1932, 117, Staner, Bull. Agr. Congo Refge, £f. 1931, 75; Storey, East Afr. Jour. 2, 1930, 31-29; Storey and Nichols, Ann. Appl. Biol., 25, 1938, 790-803; Zimmermann, Pfalancer, £, 1906. 145. Ruga verrucosans Carsner and Bennett. (Chlorogenus evtetlicola (in error for eutetligicola, from New Latin Eutettiz, genus name of a vector, and Latin cola, dweller in er inhabitant of) Holmes. 1939, foc. cit., 11; Carsner and Bennett, Science 98, 1943, 386.) From Latin, meaning: causing rough swellings.

Common name: Sugar-beet curly-top

virus.

Hosts. Very wide range in many families of diestyledonous plants. Among the horticulturally important host plants are the sugar beet (Reta vulgaris L., CHENOPODIACEAE); bean (Phaseolus vulgaris L., LEGUMINOSAE); squash (Cucrofiles species, CUCURBITACEAE); and tomato (Lycopersicon sculentum Mills. SOLAN REGAE).

Geographical distribution: Western North America; in Argentina a strain of virus thought to belong here has been reported but has not yet been fully de-

scribed.

Induced disease: In beet, clearing of veins, leaf eurling, sharp protuberances from veins on loner surface of leaves. increase in number of rootlets, phloem degeneration followed by formation of supernumerary sieve tubes, retardation of growth. In tomato, inestern yellow blight or tomate vellows), phloem degeneration followed by formation of supernumerary sieve tubes, retardation of growth, dropping of flowers and buds, rolling, vellowing and thickening of leaves. root decay, usually followed by death, sometimes by recovery. Occasionally there is relapse after recovery. In eucurbitaceous plants, stunting, bending unward of tip of runner, yellowing of old leaves, abnormally deep green in tip leaves and stem; Marblehead squash is tolerant, showing only mild nitches' broom formation and phyllody. In bean, infected when young, thickening and downward curling of first trifoliate leaf. which becomes brittle and will break early from the stem; leaves become ablamtia alant stangamu'--- t . ..

Transmission: By inoculation of expressed juice. By the tarnished plant, bug, Lygus pratessitLinn. (MIRIDAE). The insect vector retains this virus during intervals between crops.

Literature: Kaufmann, Arb. Biot. Reichsanst. Land- u. Forstw., 21, 1936, 605-623; Mitteil. Landwirtsch., 37, 1936; Pape, Deutsch. Landwirtsch. Presse, 26, 1935.

#### FAMILY V. SAVOIACEAE HOLMES

#### (Handb Phytopath, Viruses, 1939, 131.)

Viruses of the Savoy-Disease Group, causing diseases characterized mainly by crinking of foliage. Vectors, true bugs (PIESMIDAE and MIRIDAE). There is a sandle genus.

#### Genus I. Savola Holmes.

(Loc. cit., 131.)

Characters those of the family. Generic name from French chou de Savoie, cabbage of Savoy, a cabbage with wrinkled and curled leaves.

The type species is Savoia betae Holmes.

### Key to the species of genus Savola.

I Infecting beet.

- Savoia betae.
- 2. Saroia piesmae.
- II. Infecting rape and rutabaga.
- 3. Saroia napi.

1 Savota betae Holmes. (Handb Phytopath Viruses, 1939, 132) From Latin beta, beet. Common names: Beet-Kräuselkrankheit virus, sugar-beet leaf-eurl virus.

sugar-beet leaf-crinkle virus, Kopfsalat virus.

Host CHUNOPODIACEAE—Bela

tulgaris L., beet.

Geographical distribution: Germany.

Poland

Induced disease: In beet, seins of leaves swollen, retarded in growth, causing ernkling. New leaves remain small and incurved, forming a compact head. Old leaves die, plant succumbs before larvest time. Prepatent period in plant, 3 to 9 weeks.

Transmission: By tingid bug, Piesma quadrata Vieb. (PIESMID.1E). Not by inoculation of expressed juice.

Literature Wille, Arb. Biol. Reichsanst. Land-u. Forstw., 16, 1928, 115-167.

 Savoia plesmae II. (loc. cit., 132)
 From New Latin Piesma, generic name of insect vector.

Common name Beet savoy vitus, Host CHENOPODIACEAE—Beta endgorus I..., beet Geographical distribution United States (Michigan, Olno, Minnesota, Nebraska, South Dakota, Colorado, Wyoming) and Cauada.

Induced disease: In beet, leaves dwarfed, curled down, small veins thickened. Philoem necrosis in roots. Prodromal period in plant, 3 to 4 weeks.

Transmission. By tingid bug, Ptesma enerca (PIESMIDAE). Not by inoculation of expressed juice.

Literature Coons et al., Phytopath., 27, 1937, 125 (Abst.); Hildebrand and Koch, 1914, 52, 1942, 328-331.

3. Savoia napl II. (loc. cit., 133). From New Latin Napus, former generic name of rape, Brassica napus L.

Common name Rape-savoy virus.

Mosts: CRUCIFERAE—Brassica napus L., rape, B. napobrassica Mill., ruta-

baga
Geographical distribution: Germany,
Induced disease. In rape, twisting and

Induced disease. In rape, twisting and crinkling of young leaves; premature death of old bases and of plants; in surviving plants, inhibition of growth in spring. In rutalegr, mottling and crinking of leaves, with formation of fissures at leaf edge. Thants rarely killed. infective thrips. Probably not through seeds of infected plants. Not through soil.

Immunological relationships: Infects tobacco plants previously infected with tobacco-mosaic, potato-mottle, tobaccoringspot, and tomato-ringspot viruses.

Thermal inactivation: At 42° C in 10 minutes.

Filterability Passes Gradocol membrane of 0.45 micron pore diameter.

Other properties: Virus readily inactivated by desiccation or by action of oxidizing agents; activity prolonged by presence of sodium sulfite, cystein, or by low temperatures. Unstable at pH values below 6 and above 9.

Literature. Ainsworth et al., Ann. Appl. Biol., 21, 1934, 566-580; Andrewartha, Trans. Roy. Soc. of So. Australia, 61, 1037, 163-165, Bald and Samuel, shid., 21, 1034, 179-190; Berkeley, Scientific Agr., 15, 1935, 387-392, Best, Austral. Chem. Inst. Jour. and Proc., 4, 1937, 375-392; Best and Samuel, Ann. Appl. Biol., 23, 1936, 509-537; 759-780, Carter, Phytopath., 29, 1939, 285-287; Lewcock, Queensland Agr. Jour , 48, 1937, 665-672; Linford, 201d., 22, 1932, 301-324, Magee, Acr. Gaz. of New South Walcs, 47, 1936, 99-100, 118, McWhorter and Milbrath, Phytopath., 25, 1935, 897-898 (Abst.), Oregon Agr. Exp. Sta , Circ. 128, 1938; Milbrath, Phytopath., 29, 1939, 156-168; Moore, Nature, 147, 1941, 480-481; Moore and Anderssen, Union of So. Africa, Dept. Agr., Science Bull. 182, 1939, Parris, Phytopath., 50, 1940, 299-312, Rawlins and Tompkins, thid., 26, 1936, 578-587, Sakimura, ibid., 30, 1940, 281-299; Samuel and Bald, Ann. Appl. Biol., 20, 1933, 70-99; Jour. Agr. So. Australia, 37, 1933,

190-195; Samuel et al., Counc. Scient, Indus. Res., Austral., Bull. 44, 1930; Ann. Appl. Biol., 22, 1935, 508-524, Shapovalov, Phytopath., 24, 1931, 1140 (Abst.); Smith, Nature, 127, 1931, 825-853; Ann. Appl. Biol., 19, 1932, 305-330, Jour. Minist. Agr., 32, 1933, 1097-1101; Jour. Roy. Hort. Soc., 60, 1935, 304-310; Snyder and Thomas, Hilgardia, 10, 1936, 237-262; Takahashi and Hawlins, Phytopath., 24, 1934, 1111-1115; Taylor and Chamberlain, New Zealand Jour. Agr., 43, 1937, 278-283; Whipple, Phytopath., 29, 1936, 918-920.

Strains: A strain differing somewhat from the type, var. typicum H. Uoc. ch., 136), has been described as damage tomatoes in the northwestern United States. It has been given a distinctive varietal name:

1a. Lethum australiense var. lethale II. (loc. cit., 138). From Latin lethalis, Common names: Tip-blight deadly. strain of tomato spotted-wilt virus, Oregon tip-blight virus, tomato die-back streak virus, tomato tip-blight virus. Differe from the type in causing accretic leaf spotting, stem streaking, and tip blighting in most hosts, without mottling or bronzing of foliage; yet in Tropacolum majus L., there is little necrosis. In tomato, systemic necrosis, terminal shoots blighted and blackened; dead tips stand upright above living foliage. Fruits rough and pitted, with internal pockets of necrotic tissue or with subepidermal necrosis, appearing externally as concentric brown bands. (McWhorter and Milbrath, Oregon Agr. Exp. Sta, Circ. 128, 1938; Milbrath, Phytopath., 29, 1939, 156-168.)

### FAMILY VI. LETHACEAE HOLMES.

(Handb. Phytopath. Viruses, 1939, 135.)

Virus strains of the Spotted-Wilt Group, causing diseases characterized by bronzing of foliage, streaking of stems, blighting of tips, mercute spotting of foliage. Hosts, higher plants; vectors, thrips (THR/PIDAE). There is a single genus.

# Genus I. Lethum Holmes.

(Loc. etc. 135.)

Characters those of the family. Genetic name from Latin lethum, death. At present there is but one known species, though this is reported to be nearly world-wide in distribution. In some areas it may have been confused with entities needing separate recognition.

The type species is Lethum australiense Holmes.

1. Lethum australlense Holmes (loc. cit., 136). From Australia, where virus nas first described.

Common names: Tomato spotted-witt virus, kromnek or Kat River disease virus. Also, pineappls yellow-spot or side-rot virus (according to Sakimura, Phytonath. 30, 1940, 281-299).

Hosts. Very numcrous species in many families of higher plants. Among those most often noted are. SOLANACEAE—Lycopersicon exculentum Mill., tomato; Nicotiana (abocum L., tobacco; Solamus tuberosum L., potato. COMPOSITAE—Lactuce satina L., lettuce. LEGUMINOSAE—Praum satirum L., potato Merr., pincaphe. comosus Merr., pincaphe.

Geographical distribution: Australia, British Ieles, United States, South Africa Havail, New Zealand, Europe, China, South America.

Induced disease: In tomato, bronze rung-lice secondary lesions, plant stunced, some necrosas; later yellowish moease with some lead distortion. Fruit frequently marked with concentric rungs of pole red, yellow, or white. In tobacco, primary necrotic lessons followed by systemic necrosis, with stem streak, crooknew, often stunting with subsequent willing and death, sometimes temporary renvery followed by recurrence of systemic necrosis. In lettuce, plant yellowed, retarded in growth, brown blem.

ishes in central leaves, affected spots dying, becoming like parchment but with brown margins. Axillary shoots may show chloratic mottling. In pea, purplish accretic streaks on stem, at first, leaves mottled; later, necrotic spots damage foliage; pods show circular necrotic spots or wavy lines, or, if severely affected, may collapse; seeds may show necrotic lesions. In potato, zonate necrotic apota on upper leaves, necrotic streaks on stems; stems collapse at ton: plant is stunted, vield of tubers small In pineapple, at first an initial anot or primary lesion i to i meh in diameter. raised, yellowish, on upper auxlace of young leaf; later chlorotic spotting of young leaves, crook-neek because of necrotic foct in stems and fruits (side rot); plant may die,

Transmission: By inoculation of expressed juice; the addition of fine carborandum product in inoculum facilitates transmission by rubbum methods. By things, Franklintella lycoperate; Andrewartha (formerly identified as F. mauloris Franklin), F. occidentified Fegs., F. moulton (flood, and F. schulter (Trybon) (THRIPTOAE). Also by Thrips tobors Lind. (THRIPTOAE). In F. Hycoperate, thrips must pick up virus while still a nymph; virus presists through purpose and method through crust of the desired through crust of the desired through crust constitution on the mergence as adult; preinfective period in vector, 5 to 9 days. Wiras is not transmitted through eggs of Wiras is not transmitted through eggs of the second product of the desired transmitted through eggs of the second product of the desired transmitted through eggs of the second product of the desired transmitted through eggs of the second product of the desired transmitted through eggs of the second product of the desired transmitted through eggs of the second product of the desired transmitted through eggs of the second product of the desired transmitted through eggs of the second product of the desired transmitted through eggs of the second product of the desired transmitted through eggs of the second product of the second

Aerobic, facultative.

Optimum temperature 20° to 25°C.

Habitat: Water.

36 Pseudomonas punctata (Zimmermann) Chester. (Bacillus punctatus Zimmermann, Bakt. unserer Trink- und Nutzwässer, Chemnitz, 1, 1890, 35; Bacillus aquatilis communis Kruse, in Flügge, Die Mikroorganismen, 2, 1896, 315; Bacterium punctatum Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 23; Chester, Man. Determ. Bact., 1901, 313; Achromobacter punctatum Bergey et al., Manual, 1st ed., 1923, 147.) From Jatin, punctus, a puncture, point; M. L. punctate, dotted.

Rods: 07 by 10 to 1.5 micron, occurring singly, in pairs and in chains. Motile with a single polar flagellum. Gram-

negative.

Gelatin colonies: Small, circular, gray, crose to filamentous, punctiform.

Gelatin stab: Crateriform liquefaction. No pellicle.

Agar slant: Gray, smooth, filamentous. Broth: Turbid with delicate pelifele. Litmus milk. Acid; casgulated; peptonized.

Potata: Brownish-yellow to brownishred color.

Indole is formed.

Nitrites not produced from intrates. Hydrogen sulfide is formed. Acid and gas from glucose. philus Chester, Manual Determ. Bact., 1901, 235; Bacterium hydrophilum Weldin and Levine, Bact. Abs., 7, 1923, 14; Proteus hydrophilus Bergey et al., Manual, 1st ed., 1923, 211; Aeromonas hydrophilus Banier, Jour. Bact., 45, 1913, 213) From Greek, hydr, water, philus, loving; M. L. water-loving.

M. L. Water-foring.

It was reported by Russell, Jour. Amer. Med. Assoc., 52, 1898, 1442 and later by Emerson and Norris, Jour. Exper. Med. 7, 1806, 32 who made a complete study of its properties and its pathogenie action. Weldin (fown State College Jour. Sc., 1, 1927, 151) considers Bocillus ranicida Ernst (Belträge z. path. Anst. u. z. Allgemein. Pathal., 8, 1890, 201; Bacterium ranicida Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1807, 141) a possible synonym of Proleus hydrophilus.

Rods: 0.6 by 1.3 microns, occurring singly and in chains. Motile, with a single polar flagellum (Kulp and Borden, Jour. of Ract., 44, 1942, 673). Gramnegative.

Gelatin colonies: Small, circular, gray, translucent, stippled.

Gelatin stab: Napiform liquefaction. Agar colonies: Whitish, raised, moist,

stippled.

Agar slant: Thin, whitish, glassy, spreading, becoming yellowish.

Broth Turbid, with heavy pellicle.

Litmus milk: Acid; congulated; peptonized.

#### SUBORDER III. Zoophsgineae subordo novus.

From Greek phagein, to eat, and zoon, an animal. Viruses infecting animals but having no plant hosts, so far as known.

#### Key to the families of suborder Zoophaginae.

- I Inducing diseases in insects as exclusive hosts.
- Family I. Borrelinaceae, p. 1225.
- 2 Inducing diseases of the pox group Family II. Borreliotaceae, p 1229.
- 7.0 4
  - Family IV. Charonaceae, p. 1265.
- 5 Inducing diseases of the infectious anemia group Family V Trifuraceae, p. 1282
- 6. Inducing diseases of the mumns group
  - Family VI. Rabulaceae, p. 1284.

### FAMILY I. BORRELINACEAE FAM. NOV.

Viruses causing polyhedral, wilt, and other diseases in arthropods. The genus Borreling Paillot was originally spelled Borrelling by error; from Borrel, name of French scientist.

#### Key to the genera of family Borrelinscese.

- I. Known only as attacking lepidopterous insects. Genus II. Morator, p. 1227.
- Genus I. Borrelina, p. 1225. II. Known only as attacking the honey bee, a hymenopterous insect.

#### Genus 1. Borrellna Paillot.

(Compt. rend. Acad. Sci. Paris, 182, 1926, 182.)

Viruses inducing polyhedral, wilt, and other diseases; hosts, Lepidoptera, so far as known.

The type species is Borrelina bombyers Parllot.

### Key to the species of genus Borrelina.

- I Attacking silkworm.
- 1. Borrelina bombucis. II. Attacking nun moth.
- III. Attacking gypsy moth.
- 2. Borrelina efficiens. 3. Borrelina reprimens.
- IV. Attacking cabbage worm.
- 4. Borrelina brassicae.
- 5 Berrelina pieris.

1. Borrelina bombycis Paillot. (Compt. rend. Acad. Sci., Paris, 182, 1926, 182.) From Latin bombyz, silk-worm. (Note: Coccus-like bodies surrounded by non-staining substances, associated with the induced disease, received the provisional name Chlamy-dozon bombycs from Prowarek, Arch. f. Protistenhunde, 10, 1907, 363.)

Common names: Silkworm-jauadice virus, silkworm-grasserie virus, silkworm wilt virus, Gelbsucht virus, Fettsucht virus.

Host: BOMBYCIDAE-Bombyz meri (L.), silkworm.

Geographical distribution: Japan, Italy, France.

Induced disease: In silkworm, after prodomal period of 5 days or more, yellow spots on skin, polyhedral bodies in blood, inactivity, loss of appetite, irritability, weakening of body facilitating rupture from mechanical stress, eventual death.

Transmission. By feeding. Experimentally, also by injection.

Serological relationships: Specific agglutination, precipitation, and complement fixation.

Thermal inactivation: At 60° C in 15 to 20 minutes in blood.

Filterability Passes Berkefeld N and V. Chamberland L. L. and L. filters.

Other properties: May survive at least 2 years in dry state. Stable between pH 5 and about pH 9. Sedimentation constant 17 S.

Laterature: Aoka and Chigasaki, Cent. f. Bakt., I Abt., Orig., 86, 1921, 481-485; Glaser and Lacaillade, Am. Jour. Hyg., 20, 1934, 451-464; Glaser and Stanley, Jour. Exp. Med., 77, 1943, 451-466; v. Prowacek, Cent. f. Bakt., I Abt., Orig., 67, 1912, 268-284, Suzuki, Bull. Imperial Kyoto Sericultural College, 1, 1929, 45-75, Trager, Jour. Exp. Med., 61, 1935, 501-513.

2. Borrelina efficiens spec. nov. From

Latin efficiens, effective, in reference to effectiveness of this virus in controlling nun-moth infestations.

Common names: Nun-moth disease virus, nun-moth wilt virus, Wipfelkrankheit virus.

Host: LYMANTRIIDAE-Lymantria monacha (L.), nun moth.

Geographical distribution : Europe.

Induced disease: Ineggs, larvze, pupos and occasionally adults of nun moth, polyhedral bodies in affected tissues, Blood of sick larvae turbid; later, blood cells few; contents of body finally become a gray-brown, semifluid mass,

Transmission: By feeding,

Thermal inactivation: At 55 to 60° Cla 5 to 10 minutes.

Filterability: Fails to pass Berkefeld and Chamberland filters.

Other properties: May remain viable at least 2 years in dry state.

Literature: Escherich and Miyajima, Naturwissens, Ztschr. f. Forst u. Land-wirtschaft, 9, 1911, 381-402; Wachii and Kornauth, Mitth. a. d. forstl. Versuchsween Obstreichles, 16, 1833, 1-35; Wal), Contralbl. Cesam. Forstw., 55, 1903, 161-172; 212-215; 59, 1910, 377-397; 37, 1911, 247-263; 58, 1912, 335-376.

3. Borrelina reprimens spec. nov. From Latin reprimere, to restrain.

Common name: Gypsy-moth wilt virus. Host: LYMANTRIIDAE-Porthe-

tria dispar (L.), gypsy moth.

Geographical distribution: United
States.

Induced disease: In gypsy moth eaterpillar, flaceidity, disintegration of tissues, eventual collapse as a watery sack. Death occurs in 13 to 29 (average 21) days after unfection; eaterpillar may remain attached to its support by prolegs; skin ruptures easily. Polyhedral bodies oriinate in nuclei of the trachesi matris, hypodermal, fat, and blood cells.

Transmission: By feeding on contam-

insted foliage. Not through undamaged skin.

Filterability: Passes Berkefeld N. not. Pasteur-Chamberland F. filter.

Literature: Chapman and Glaser, Jour. Econ. Entoniol., 8, 1915, 140-150; 9, 1916. 149-167; Glaser, Jour. Agr. Res., 4, 1915. 101-128; Science, 48, 1918, 301-302; Glaser and Chapman, Jour. Econ. Entomol., 6, 1913, 479-488

4. Borrelina brassicae Paillot. (Compt. rend. Acad. Sci., Paris, 182, 1926, 182.) From name of host, Pierre brassicae.

Common name: Cabbage-worm prass.

erie virus. Host: PIERIDAE-Pieris brassicaces

(L.), cabbage worm. Induced disease: In cabbage worm nuclear or cytoplasmic inclusions; au no of fat and hypodermal cells hypertropole; and soon disorganized.

Transmission: By feeding, Other properties, Described

microscopic fa size, intracytop'as sub-Appendix: Borrelina flache prinic.

535 pp., Trevoux, Patissier, 1'as quoted from Paillot, L'infection chez les insects.

more L. No previous refered as a Ra. Cause of Estitue in the silknorm, Hombyz Genus 11. More of this species has been found.

Only one species at present, inducing the bec. Generic name from Latin morator, to gen. nov. Slorafor actatulae spec. nor.

I. Morator actatulae spec nor. I'rom Latin actatula, early period of life, in reference to attack on unmature stages of host, exclusively-

Common name Honey bee sacbrood virus.

Host: APIDAE~Apis mellifera L., honey bee (immature stages only).

Insusceptible species LYMANTRII-DAG-Porthetria dispar (L.), gypsy moth.

Geographical distribution: United States.

Literature: Pasliot, loc. cit.; Ana. Inst. Pasteur, 40, 1926, 314-452; L'infection ches les insectes. Immunité et symbiose, 535 pages, Trêvoux, Patiesier, 1933.

5. Borrellas piesis Paillot. (Compt. rend. Acad Sci., Paris, 182, 1926, 152.) From New Latin Pro-

of pierids. le: Virus of nuclear disease

Host: P17. (L.), cabbo CRIDAU-Pieris brassicae

Induce ize sorm.

d disease: In cabbage worm, wheel bef yellowish below, teors easily just tracore death; chromatin of nuclei in fat and blood cells condensed in irregular masses; cytoplasmic inclusions staining faintly red in Glemsa preparations.

Transmission: By feeding Other properties: Described as intraeytoplasmie, less than 0.1 micron in diameter

Literature: Paillot, loc. col.; Ann. Inst. Pasteur, 40, 1926, 314-452; L'infection ches les insectes. Immunité et symbiose, 535 pages, Trévoux, Patissier, 1933.

wase known as sachrood of the honey r. The type, and only, species is

Scheed disease: In the honey bee, sole are stages only are susceptible; inthe larvar die, usually after capping, tulf the dead brood being uncapped by alles Oc asjonally caps are punc-Affects if areas of comb are usu-"mail and scattered. Lach larva is duded along its cell, head turned updemard the rool A larva recently Mappears light yellow, light gray, or Et brown, roon darkening to brown or wat black Cuttele of dead larva 25. permitting extraction of the arclike mass without rupture; contents watery with many suspended, fine, brown particles. There are no characteristic intracellular bodies in affected tissues. Dead larvae eventually dry down to form scales that are black and roughened, that separate readily from the cell wall, and that may be lifted out intact. Colonies tend to lose virus spontaneously.

food. Not by hands, clothing, or tools, Perhaps through water supply of insects. Thermal inactivation: In water at 58°

Transmission: By contamination of

C in 10 minutes. In honey, at 70 to 73° C in 10 minutes.

Filterability: Passes Berkefeld and Pasteur-Chamberland filters.

Other properties: Withstands drying 20, not 22, days, exposure to sunlight? hours or less, storage in honey a month or more, 1 to 2 per cent aqueous solutions of carbolic acid 3 weeks or more.

Literature: McCray and White, U. S. Dept. Agr., Dept. Bull. 671, 1918; White, U. S. Dept. Agr., Bur. of Entomol., Circ 169, 1913; U. S. Dept. Agr., Dept. Bull. 92, 1914; ibid., Dept., Bull. 431, 1917.

#### FAMILY II. BORRELIOTAGEAE FAM. NOV.

Viruses of the Pox Group, inducing diseases characterized in general by discrete primary and secondary lesions of the nature of macules, papules, vesicles, or pustules.

## Key to the genera of family Borrellotaceae.

 Viruses of the Typical Pox-Disease Group. Genus I. Borreliota p 1229.

II. Viruses of the Varicella Group

Genus II. Briareus, p 1233 III Viruses of the Herpes Group.

Genus III. Scelus, p. 1234.

Genus III. Scelus, p. 1234.

IV. Viruses of the Foot-and-Mouth-Disease Group.

IV. Viruses of the Foot-and-Mouth-Disease Group Genus IV. Hostis, p. 1239

V. Viruses of the Wart-Disease Group. Genus V. Molitor, p. 1240.

## Genus I Borrellota Goodpasture.

(Science, 77, 1933, 121.)

Viruses of the Typical Pox-Daesas Group, inducing diseases characterized by formation of papules, pustules, and scales, shed with or without scarring. Generic name from Borrel, investigator who first discovered the specific granules of fowl pox and Latinized name of the smallest Greek letter, iola, signifying smallest particle. The name Optorystes surveloe Guarneri 1852 was based on intracellular inclusions, Guarnieri bodies, as supposed sporoscan parasites (Cafkins, Jour. Med. Res., II, 1904, 136-172).

The type species is Borreliola arrum Goodpasture.

### Key to the species of genus Borreliota.

I. Affecting domestic fowl.

1. Borreltota avium.

II Affecting man principally, although strains have become adapted to cow, rabbit, etc.

2 Borreliota variolae.

III Affecting swinc.

3. Borreliota suis.

1 Borrellota avlum (Lipschletz) Goodpacture. (Strongyloplasma arum Lipschittz, in Koffe, Krauv and Uhlenhuth, Handluch der pathogenen Mikroorgunismen, 3 Auft., 8, 1930, 314, Goodpasture, Science, 77, 1933, 121) From Latin ares, food of the air.

Common names Fowl-pox virus; also known as poultry-pox virus, chicken-pox virus (but not the virus of the same name attacking man rather than the chicken), or virus of epithelioma contagiosium of lowls; strains have leven studied under

the names Kikuth's canary virus and pigeon-pox virus,

Hosta Chicken, turkey, pigeon, goose, duck, guinea fowl, quail, hawk, pheasant, partridge, bunting sparrow, canary. Experimentally, also English sparrow, chick embrao.

Insusceptible species: Man, goat, sheep, mouse, rat, guines pig.

Geographical instribution: Europe, Asia, North America; perhaps coextensive with the area in which chickens are grown under conditions of dom streation.

Induced disease: In chicken, hyperplastic nodular lesions of the skin, diphtheritie membranes in mouth and throat, discharges from eyes and nose; nodules eventually dry up and foll off, usually without leaving scars. Inclusion bodies, known as Bollinger bodies, believed to represent aggregates of minute Borrel bodies or virus particles, leave much grayish-white ash when incinerated; break readily after digestion by I per cent trypsin in 0.2 per cent sodium bicarbonate. Borrel bodies coccold, 0.25 microns in diameter. On choricalizatoic membrane of chick embryo, proliferation and hyperplasia, or necrosis.

Transmission: By contoct, perhaps through wound infection. By bloodauching dipterous insects. Experimentolly, by scarification of skin or buccal mucosa; by intravenous, intradermal, subcutaneous, intramuscular, or intraperitoneal inoculation. May be passed in series by nasal instillation in chickens, obvious mucosal changes occurring only occasionally Experimentally, by mosquitoes (CULICIDAE), Aedes aegypti L., A. stimulans Walker, A. vexans Meigen (as long as 27 days from time of feeding on infective material), and Culex pipiens L. (indefinitely after infective feeding, as long as the individual mosquito lives); in C. pipiens, the virus has been found also under natural conditions.

Serological relationships: Neutralizing and elementary-body-agglutinating antisera specific. Antivaceinal serum from rabbit ineffective against fowl-pox virus, although neutralizing vaccinia virus.

Immunological relationships: No cross immunity with respect to vaccinia virus in the chicken.

in the chicken.

Thermal inactivation: At 60° C in 8 minutes: at 56° C in 30 minutes.

Filterability · Passes Berkefeld V, not Chamberland L<sub>4</sub>, filter candle. Other properties: Drying at room tem-

perature in vacuo does not inactivate. Viable after storage at least 24 months at 0 to 4° C, dry.

Strains: A strain known as Kikuth's

canary virus has been studied in some detail. When introduced into the rabbit it induces formation of neutralizing antibodies that react strongly with homologous virus, moderately against fowl-pox virus. Antivaccinial serum is ineffective against it. In canaries, it induces proliferation of dermal epithelium with cytoplasmic inclusions, the inflammatory process being characterized by predominantly mononuclear cells with vacuolated cytoplasm; in the lung there is massive accumulation of large mononuclear cells containing the specific cytoplasmic inclusions; the disease is regularly fatal. Passes Berkefeld N filter. Size estimated as 120 millimicrons by centrifugation. (Bechhold ond Schlesinger, Ztechr. f. Hyg., 115, 1933, 354-357; Burnet, Jour. Path. and Bact., 57, 1933, 107-122; Burnet and Lush, Brit. Jour. Exp. Path., 17, 1936, 302-307; Gaede, Cent. f. Bakt., I Abt., Orig., 188, 1935, 342-346; Kikuth and Gollub, ibid., 125, 1932, 313-320.)

Literature: Andervont, Am. Jour. Hyg., 6, 1926, 719-751; Brandly and Dunlap, Jour. Am. Vet. Med. Assoc., 95, 1939, 340-349; Brandly et al., Am. Jour. Vet. Res., 2, 1941, 190-192; Brody, Cornell Agr. Exp. Sta. (Ithaca). Memoir 195, 1936; Buddingh, Jour. Exp. Med., 67, 1938, 933-940; Burnet and Lush, Brit. Jour. Exp. Path., 17, 1936, 392-307; Danks, Am. Jour. Path., 8, 1932, 711-716; Findlay, Proc. Roy. Soc. London, Ser. B. 102, 1928, 351-379; Goodpasture and A. M. Woodruff, Am. Jour. Path., 6, 1930, 699-712, Goodpasture and C. E. Woodruff, tbid., 7, 1931, 1-8; Irons, Am. Jour. Hyg., 20, 1934, 329-351; Kligler and Ashner, Proc. Soc. Exp. Biol. and Med., 28, 1931, 463-465; Kligler et al., Jour. Exp. Med., 49, 1929, 649-660; Ledingham, Lancet, 221, 1931 (2), 525-526; Ludford and Findley, Brit. Jour. Exp. Path., 7 1926, 256-264; Matheson et al, Poultry Science, 10, 1931, 211-223; Megmil, Am. Jour. Hyg , 9, 1929, 462-465; Nelson, Jour. Exp. Med., 74, 1941, 203-212; A. M. Woodruff, and Goodpasture, Am. Jour.

Path., 7, 1931, 209-222; C. E. Woodruff, 1bid., 8, 1930, 169-174; C. E. Woodruff, and Goodpasture, 1bid., 8, 1929, 1-10, 6, 1930, 713-720.

2. Borreliota variolae (Lipschutz)
Coodpasture. (Stronguloplasma rorrolae
Lipschutz, in Kolle, Kraus and Uhlenhuth, Handhuch der pathogenem Mikroorganismen, 3 Aufl., 8, 1930, 317; Goodpasture, Science, 77, 1933, 121.) From
New Latin cariolo, smallpox.

Common names Variola virus, smallpor virus. Most studies of this virus have been concerned with the vaccinia

strain; see Strains below.

Hosts Man, row and rabbit are susceptible to strains that appear especially adapted to them (see Strains below). Experimentally, also chicken (and chicksumbrys). Chyrennys morginata, turtle, nunea pig, horse, pig, Macaca mulatia (Emmerman), thesus monkey, M. russynomolgus monkey, ornag-outang; Maceus fuscature.

Cographical distribution: Nearly world-wide, except where excluded by isolation or protective vaccination.

Induced disease: In man, mild to severe smallpox, cometimes with pocks few and discrete but often with pocks numerous and coalescing, onset audden. 6 to 22 days (average 12) after enfection headache, vomiting, fever, often rashes on body before appearance of the specific eruption, bright red spots becoming vesicular and eventually pustular, the pocks are commonest on face, forearms, wrists, palms of hands, and soles of feet : pustules gradually become flattened scabs and drop off, leaving no sear if superficial and not secondarily infected; in hemorrhagic smallpor there are numerous hemorrhages into the skin and mortality is bich, death often preceding formation of pustules: revertty of disease and mortality roughly proportional to the amount of cruntion on the face

Transmission By centact with infected individuals or contaminated articles, perhaps by droplet infection,

obvious primary lesions characterizing experimental transmission by scarification but not natural spread.

Samtorical relationships: Hyperimmone calf serum neutralizes virus. Neutrabzation depends on an antibody not speolved in agglutination and precipitation Antivaccinial serum gives complement fixation in the presence of variola virus. One agglutinogen (L) labile at 56° C. one (S) stable at 95° C: both are parts of a single protein but can be degraded independently; chymotrypsia destrove activity of S, not L. Increasing neutenlization in immune serum and virus mixtures in vitro with progressive incubation : partial reactivation on supple dilution. Antivaccinial sera agglutinate Paschen bodies of vaccinia but not Borrel bodies of fowl por; anti-fowl-pox sers azglutinate Borrel but not Paschen bodies. No cross reactions with bernes virus.

Immunological relationships: In vaccinia-immune artice, protective subetances pass via colostrum, conveying passive immunity to young for 2 to 3 months after birth. In man, immunity against variols virus as conferred by earlier infection with vaccina strain. In heap, previous infection with fort-porvirus does not immunize with respect to vaccinat virus.

Thermal mactivation: At 55° C in 20 minutes.

Filterability. Passes Berkefeld V, not Mandler, filter.

Other properties: Density about 1.16. Sedimentation constant 5000 × 10<sup>-1</sup> feorrected to water at 20° C). Retains activity in glycerus beat at pH 7.0. Of per cent gelatin delaya spontaneous inactivation at 5 to 10° C. Withstands absolute alcohol, ether, acctine, and petrofeum ether 1 hour in dry samples at 4° C without decrease in activity. Inactivated without disruption by sonic vibrations of about 5000 cycles per second. Darmeter estimated as 125 to 175 millimicrons by fitration; 236 to 222 millimicrons by diffraction; 126 to 127 millimicrons by ultracentrifugation. Electron micrographs show hunting surface.

membrane, dense granules (usually 5) within; tendency to rectangular outlines with rounded corners. At least 5.6 per cent of virus is reported to be thymonucleic acid. Contains nitrogen, 15.3 per cent; earbon, 33.7 per cent; phospholipid (lecithin), 2.2 per cent; neutral fat, 2.2 per cent; reducing sugars after hydrolysis, 2.8 per cent; cystine, 1.9 per cent; copper, 0.05 per cent.

Strains: Besides the typical variola strain, var. hominis Goodpasture (Science, 77, 1933, 121), several distinctive strains have been studied. A spontaneous cowpox strain differs in some antigens but affords cross immunity with respect ta var. bovis Goodpasture (loc. cit., 121), vaccinia virus, which in turn immunizes against typical variola virus. A spontaneous rabbit-pox strain, serologically resembling neurovaccine virus, is belioved to exist independently in Europe and the United States. The varieties equi (horse-pox virus), porci (swine strain), and ovium (sheep and goat pox virus) have been attributed to this species by Goodpasture (loc. cit., 121). The alastrim strain (causing variola minor) differs from the type in producing a relatively mild disease in man and in inducing the formation of a distinctive type of intracellular inclusion in affected tissues.

Laterature Amies, Jour. Path and Bact., 47, 1938, 205-222, Andervont, Am. Jour. Hyg., 7, 1927, 804-810, Behrens and Ferguson, Jour Inf. Dis., 56, 1935, 84-83; Behrens and Nielson, ibid., 56, 1935, 41-48; Buddingh, Am. Jour. Hyg., 58, 1943, 310-322; Craigie and Wishart, Brit. Jour. Exp. Path., 15, 1934, 390-398; Jour. Exp. Med , 64, 1936, 819-830, Dearing, Am. Jour. Hyg., 20, 1934, 432-443; Douglas et al., Jour. Path. and Bact., 52, 1929, 99-120; Downie, Brit. Jour. Exp Path., 20, 1939, 15S-176; Engles, thid., 16, 1935, 181-188; Elford and Andrewes, Brit. Jour. Exp. Path , 18, 1932, 35-42, Goodpasture, Woodruff, and Buddingh, Am. Jour. Path., 8, 1032, 271-282; Green et al., Jour. Exp. Med., 75, 1942, 651-656,

Greene, ibid., 61, 1935, 807-831; Herzberg Zischr. Immunitatsforsch. u. evper Therap., 86, 1935, 417-441; Hoagland e al., Jour. Exp. Med., 71, 1940, 737-750; 78 1940, 139-147; 74, 1941, 69-80, 133-144 76, 1942, 163-173; Hu et al., Jour. Exp. Med., 63, 1936, 353-378; Keogh, Jour. Path. and Bact., 43, 1936, 441-451; Ledingham, Brit. Jour. Exp. Path., 5, 1924, 332-349; Jour. Path. and Bact., 35, 1932, 140-142; Macfarlane and Dolby, Brit. Jour. Evp. Path., 21, 1940, 219-227; Macfarlane and Salaman, ibid., 19, 1938, 184-191; McFarlane et al., ibid., £0, 1939, 485-501; Moriyama, Arch. f. Virusforsch., 1, 1940, 422-429; Nelson, Jour. Evp. Med., 60, 1934, 287-291; 78, 1943, 231-239; Nye and Parker, Am. Jour. Path., 5, 1929, 147-155; Parker, Jour. Evp. Med., 67, 1938, 361-367, 725-738; Parker and Muckenfuss, Jour. Infect. Dis., 65, 1933, 44-54; Parker and Rivers, Jour. Exp. Med., 62, 1935, 65-72; 64, 1936, 439-452, 65, 1937, 243-249; Paschen, Deutsch. med. Wehsehr., 59, 1913, 2132-2136; Pearce et al., Jour. Exp. Med., 63, 1936, 241-258, 491-507; Jour. Path. and Bact., 43, 1936, 299-312; Pickels and Smadel, Jour. Exp. Med., 68, 1938, 583-606; Rhodes and van Rooyen, Jour. Path. and Bact., 44, 1937, 357-363, Rivers and Ward, Jour. Exp. Med., 58, 1933, 635-618; 62, 1935, 549-560; Rivers et al., sbid., 65, 1937, 677-685; 69, 1939, 857-866; Rosahn ct al., Jour. Exp. Med., 63, 1936, 259-276, 379-396, Rosenau and Andervont, Am. Jour. Hyg., 13, 1931, 728-740, Salaman, Brit. Jour. Exp. Path., 18, 1937, 245-258; Shedlovsky and Smadel, Jour. Exp. Med., 75, 1942, 165-178; Smadel and Rivers, thid., 75, 1942, 151-164, Smadel et al., thid., 68, 1933, 607-627; 71, 1940, 373-389; 77, 1943, 165-171 , Smith, Jour. Path. and Bact., \$3, 1930, 273-282, Sprunt, Proc. Soc. Exp. Biol. and Med., 51, 1942, 226-227; Jour. Exp. Med., 75, 1942, 297-304; Stritar and Hudson, Am. Jour. Path., 12, 1936, 165-174; Ward, Jour. Exp. Med., 50, 1929, 31-40.

3. Borreliota suis spec. nov. From Latin sus, swine.

Common name: Swine-pox virus (not

the vaccinia strain of variola virus in swine). Host · SUIDAE—Sus scrofa L., domes-

tie swine.

Insusceptible species: Rabbit.
Geographical distribution: United

States (lawa).

Induced disease: In anine, locally, reddened hyperemic papiles 3 to 7 mm an
diameter; papules become briefly vesticular, then change gradually to true pustules, finally forming dark brown to
blackish seabs which are shed after a few
weeks without scarring; no secondary
lessons in loga free from hee, but in iafested animals numerous secondary lesons appear 1 to 2 weeks after primary
lesions and are commonly roost numerous
in the inguinal and avillary regions.
Mortality negligible but growth retarded.
Mortality negligible but growth retarded.

Virus has been recovered from hog louse after feeding on affected swing.

Transmission By hog louse, Haematopinus 2018 (HAEMATOPINIDAE), probably mechanically. By experimental scarification of shin.

Serological relationships. No reaction with neutralizing sera specific for vac-

cinia virus.

Immunalarical relationships: Specific

summusity in swine after attack, but no cross immunity with respect to vaccinia virus.

Filterability: Passes Berkefeld V and N filters.

Laterature: Csontos and von Nyiredy, Deutsch tierärzti. Wehnschr., 41. 1933, 529-532, Schwarte and Biester, Am. Jour. Vet Res., 2, 1941, 135-140, Shope, Arch. I. Virusforsch. 1, 1910, 457-467.

### Genus II. Briareus gen nov.

Viruses of the Vericella Group, causing diseases characterized by reddened spots and rings in affected tissues, becoming papular or vesicular. Generic name from Latin Briareas, name of a hundred-armed giant.

The type species is Briareus caricellae spec. nov.

## Key to the species of genus Bilareus.

I. Causing chicken pox and herpes zoster in man

Briareus saricellae.

II. Causing measles in man.

11. Causing measies in man

1 Brisreus varicellae apec. nor. From New Latin serscella, chicken pox.

Common names: Varicella virus, chielen pox virus, much evidence for identity with ro-called herpes-zoster virus has been presented.

Host HOMINIDAE-Home suprens L, man

Insusceptible species: Chick embryo. Geographead diverbution: World-wide. Induced diverse: In man, usually abrupt onset, rash at first macular, soon pepular and versicular; seeicles generally ducerte, soon rupturing, healing with seah formation and itching; separation of deeper scale may leave persistent scars; in severe cases there may be atomatica, largequit, and easal lections. In human shin rrafted on their follatoits of chief.

## 2. Bracreus morbillorum.

embryo, experimentally, pustular lesions as an natural disease, with intranuclear acidophilic inclusions, no gross vesiculation

Transmission By contact. By spread of droplets Children in contact with herpes zoster patients sometimes contract varicella

Secological robbinships Majority of herpes noster era that anglutinate roster antigen also argitutinate elementary bodies of varicella; complement firstion tests also indicate relationship of virus from herpes soster and varicella. Chichen-pox sera do not floculate smallpox brain-virus antigen.

Immunological relationships: Children previously having varicella are immune to looculation with herpes soster virus. Literature: Amies, Brit. Jour. Lap. Path., 15, 1934, 314-320; Brain, tbid., 14, 1933, 67-73; Bruusgaard, Brit. Jour. Derm. Syph., 44, 1932, 1-24; Goodpasture and Anderson, Am. Jour. Path., 29, 1944, 447-453; Havens and Mayfield, Jour. Int. Dis., 59, 1932, 242-243; Irons et al., Mm. Jour. Hyg., 52, (8), 1941, 50-55, Kundratitz, Monateschr. Kinderheilk., 29, 1925, 516-523, Lipsehutz and Kundrastitz, Wien. klin. Woeh., 53, 1925, 590-503.

2. Briareus morbiliorum spec. nov.

From New Latin morbilli, measles.

Common name Measles virus.

Host: HOMINIDAE—Homo sapiens L., man. Experimentally, also CERCO. PITHECIDAE—Moccea mulatta (Zimmerimann), rhesus monkey. PHASI-ANIDAE—Gallus gallus (L.), chick embryo (no lesions, but 30 serial passages).

Geographical distribution World-wide except in isolated communities.

Induced disease. In man, after incubation period of 7 to 21 days, bright red spots on buccal mucesa, especially near first molar tooth (Koplik's spots) followed by rash on face, head, neck, then arms, trunk, and legs; popules often crescents, lesions usually discrete; rash fades, leaving brownish discoloration and desquamation.

Transmission: By contact. By drop-lets.

Scrological relationships: Convalescent scrum is reported to modify the course of the induced disease if administered intravenously in the precruptive stage.

Immunological relationships: Specific immunity in man after attack.

Thermal inactivation: At 55° C in 15 minutes.

Filterability: Passes Berkefeld N filter candle and Scitz EK disks.

Other properties: Viable at -33° C for at least 4 weeks. Not inactivated by 10 per cent anesthetic ether in 40 minutes. Literature: Blake and Trask, Jour. Exp. Med., 53, 1921, 385-412; Gordon and Knighton, Am. Jour. Path., 17, 1941, 165-176, Hedrich, Am. Jour. Hyx., 17, 1933, 613-636; Kohn et al., Jour. Am. Med. Assoc., 111, 1938, 2361-2364; Rake and Shaffer, Jour. Immunol., 58, 1940, 177-209; Rake et al., Jour Inf. Dis., 69, 1941, 63-69; Scott and Sımon, Am. Jour. Hyg., 5, 1928, 109-126.

## Genus III. Scelus gen. nov.

Viruses of the Herpes Group, inducing diseases characterized in general by residuar primary lesions, sometimes with subsequent involvement of the hervous system. Generic name from Latin sectus, rascal.

The type species is Scelus recurrens spec. nov.

# Key to the species of genus Scalus.

- I In man, cause of so-called fever blisters, herpes febrilis

  1. Scelas recurrens.
- II In swine, cause of pseudorabies
- III. In monkey
  - 3. Scelus beta.
- IV. In rabbit, course of the induced disease in nature unknown.
  - 4. Scelus tertium.

    V In sheep, cause of ovine halano-posthitis.
- VI In mice, cause of extremelia
- 5 Scelus ulceris.

  6. Scelus marmorans.

2. Scelus suillum.

VII. In cattle, cause of crosive stomatitis.
7. Scelus bovinum.

mice, guinea pigs and rabbits, causing hemorchagic septicemia

Distinctive characters. Much like Pseudomonas nunciata (Guthrie and Hitchner, Jour. Baet., 45, 1943, 52). Source: Isolated from from dead of septicemia (red leg).

Habitat: Water and infected fresh

water animals

38. Pseudomones ichthyosmia (Hammer) comb. nov. (Bacillus ichthyosmius Hammer, Iona Agr Sta Res Bul 3S, 1917; Escherichia ichthyosmia Bergey et al., Manual, 1st ed., 1923, 201, Proteus ichthyosmius Bergey et al , Manual, 4th ed . 1931, 364) From Greek, schihus, a fish; osmē, an odor.

Rods: 0 6 to 0.8 by 1.0 to 21 microns, occur singly. Motile with a single polar flagellum (Breed). Gram-negative

Gelatin stab: Liquefaction

Agar colonies: Small, white, becoming

darker with ago.

Agar slant : Dirty white, viscid growth Broth. Turbid with gray sediment Litmus milk. Acid. Litmus reduced

Cultures have fishy odor Potato: Thin, glistening layer

Indole is formed. Nitrites produced from nitrates

Acid and gas from plucose, fructose, galactose, maltose, sucrose, glycerol, salicin and mannitol. Lactose, dulcitol, raffinose and inulin not fermented

Aerobic, facultative.

Optimum temperature 20°C Source: Isolated from can of evaporated

milk having a fishy odor. Habitat: Not known.

39. Pseudomonas ambigua (Wright) Chester. (Bacillus ambiguus Wright, Memoirs Nat. Acad Sci , 7, 1895, 439, Chester, Man. Determ. Bact., 1901, 308; Achromobacter ambiguum Bergey et al , Manual, 1st ed . 1923, 148 ) From Latin, ambiguus, doubtful, uncertain.

Small rods, with rounded ends, occurring singly, in pairs and in chains Motile, possessing a polar flagellum. Gramnegative.

Gelatin colonies: Gray, translucent. slightly raised, irregular, radiate, with transparent margin.

Gelatin stab . No liquefaction.

Agar slant, Grav, limited, entire. Broth: Turbid, with gray sediment. Litmus milk · Acid, slowly congulated. Potato: Gray to creamy.

spreading. Indole is formed.

Nitrites not produced from nitrates. Acrobic, facultative.

Optimum temperature 30° to 35°C. Habitat: Water.

40. Pseudomonas sinuosa (Wright) Chester (Bacillus sinuosus Wright, Memoirs Nat. Acad. Sci., 7, 1895, 440; Chester, Man. Determ. Bact., 1901, 307; Achromobacter sinosum (sic) Bergev et al., Manual, 1st ed , 1923, 148.) From Latin, sinuosus, full of bends, sinuous

Medium-sized rods, with rounded ends, occurring singly, in pairs and in chains. Motile, possessing two to four polar flagella Gram-negative.

Gelatin colonics: Thin, translucent,

irregular, center brownish.

Gelatin stab. Gravish-white, glisten-

ing. translucent No liquefaction. Agar slant Scanty, grayish growth. Broth. Turbid, with gray sediment.

Litmus milk: Unchanged. Potato, Gravish-white, moist, spread-

ing. Indole is formed.

Nitrites not produced from nitrates. Aerobie, facultative

Optimum temperature 30° to 35°C. Habitat, Water.

41 Pseudomonas cruciviae Gray and Thornton (Gray and Thornton, Cent. f Bakt., II Aht., 73, 1928, 91; Achromobacter cruciviae Bergey et al., Manual, 3rd ed , 1930, 218 ) From Latin, crux, a cross, 116, way, road; from Wayeross, a place name.

f. Hyg., 115, 1933, 342-353; Bedson, Brit. Jour. Exp. Path., 12, 1931, 254-260; Bedson and Bland, ibid., 9, 1928, 174-178; Blanc and Caminopetros, Compt. rend. Soc. Biol., Paris, 84, 1921, 859-860; Boak et al., Jour. Exp. Med., 71, 1940, 169-173; Brain, Brit. Jour. Exp. Path., 15, 1932, 166-171; Buggs and Green, Jour. Inf. Dis., 58, 1936, 98-101; Burnet and Lush, Jour. Path. and Bact., 48, 1939, 275-286; 49. 1939, 211-259; Lancet, 256, 1939 (1), 629-631; Burnet et al., Austral. Jour. Exp. Biol. and Med. Sci., 17, 1939, 35-49; Dawson, Am. Jour. Path., 9, 1933, 1-6; Elford et al., Jour. Path. and Bact., 36. 1933, 49-54; Findlay and MacCallum, Lancet, 258, 1940 (1), 259-261; Fischland Schaefer, Klin. Wochnschr., 8, 1929, 2139-2143; Flexner, Jour. Gen. Physiol., 8, 1927, 713-726; Jour. Exp. Med., 47. 1928, 9-36, Friedenwald, Arch. Ophthalmol., 52, 1923, 105-131; Goodpasture. Medicine, 8, 1929, 223-243; Goodpasture and Teague, Jour. Med. Res., 44, 1923. 121-138; Gunderson, Arch. Opthalmol., 16, 1936, 225-249, Holden, Jour. Inf. Dis., 50, 1932, 218-236, Reddie and Epstein, Jour. Am. Med. Assoc , 117, 1941, 1327-1330, Levaditi and Lepine, Compt. rend. Acad Sci., Paris, 180, 1929, 66-68, Levadittand Nicolau, Compt rend. Soc. Biol , Paris, co, 1924, 1372-1375; Long, Jour. Clin. Investigation, 12, 1933, 1119-1125; Magrassi, Boll. Ist. Sieroterap. Milanese, 14, 1935, 773-790, McKinley, Proc. Soc. Exp. Biol. and Med., 26, 1928, 21-22, Naegeli and Zurukzoglu, Cent. f. Bakt. I Abt., Orig , 185, 1935, 297-299, Nicolau and Kopciowska, Ann. Inst. Pasteur, 69, 1938, 401-431, Parker and Nye, Am. Jour. Path., 1, 1925, 337-340, Perdrau, Proc. Roy, Soc London, Ser. B, 103, 1931, 304-308, Jour Path and Bact., 47, 1938, 447-455; Remlinger and Bailly, Comp. rend. Soc. Biol , Paris, 94, 1926, 734-736; 1064-1066, 95, 1926, 1512-1545; 96, 1927, 404-406; 1126-1128, 97, 1927, 109-111, Sabin, Brit. Jour Exp Path., 15, 1934, 372-380; Schultz and Hoyt, Jour. Immunol., 15, 1928, 411-419; Shaffer and Enders, 151d., 57, 1939, 383-411; Simon, International

Clinics, Series 37, 5, 1927, 123-123; Smith et al., Am. Jour. Path., 17, 1941, 55-68; Warren et al., Jour. Exp. Mad., 71, 1940, 155-163; Weyer, Proc. Soc. Exp. Biol. and Med., 59, 1932, 309-313; Ziusser, Jour. Exp. Med., 49, 1929, 661-670; Zinsser and Seastone, Jour. Immunol., 18, 1930, 1-9; Zurukzoglu and Hruszek, Cent. f. Bakt. I Abt., Orig., 128, 1933, 1-12.

 Sceles sullium spcc. nov. From Latin suellus, pertaining to swine.

Common names: Pseudorables virus, mad-itch virus.

Hosts: Domestic cattle, swine, dog, cat, hoses, sheep. Experimentally, also rabbit, guinea pig, white rat, white mouse, gray field mouse, duck, chicken, chick embryo; Macaca mulatta (Zimmermana), rhesus monkey.

Geographical distribution: France, Germany, Hungary, Holland, Denmark, Switzerland, Siberia, Brazil, United States.

Induced disease: In cattle, licking of affected area, usually somewhere on hind-quarters, sudden decrease in milk production in dairy animals, unlent rubbing, biting, and gnawing of lesion; swelling and discoloration of affected parts with cozing of serosanguineous fluid; grinding of teeth and excessive salivation in some individuals; death, preceded by clonic convulsions, violent tossing of head, and shallow respiration, usually 36 to 48 hours after onset. In pig, mild but highly contagious disease; slight nerve-cell degeneration, predominance of vascular and interstitual lesions.

Transmission: By contact in swine, not in cattle. By feeding in cats, brown rats, and swine.

Scrological relationships: Cross neutralization between constituent strains. Anti-herpes sera protect in some cases against small, but constantly infective, doses of pseudorables virus.

Literature: Aujeszky, Cent. f. Bakt. I Abt., Orig., 52, 1902, 353-357; F. B. Bang, Jour. Exp. Med., 76, 1942, 263-270;  Seelus recurrens spoc. non. From Latin recurrer, to recur. Note: The name Neurocystiv herpetii Levaditi and Schoen (Compt. rend. Soc. Biol., Paris, 96, 1027, 681) was applied provisionally to the causative microorganism of herpes, in the expectation that future research would show inclusion bodies in affected tissues to be stagon in its life cycle.

Common names: Herpes virus, virus of herpes simplex, virus of herpes febrilis (not herpes zoster virus, for which see varicella virus), virus of keratitis dendritica, virus of aphthous stomatitis (of man).

Host. HOMINIDAE—Home capters L, man. Experimentally, also rabbit, guinea pig, white mouse, est, goose, hedge-hog, and, though difficult to infect, dog and pigeon. Chick embryo (but not chicken). Also CERCOPITHECHDAE—Cercoccus Julignouss E. Geoffrey, Macticus cynomelpus, CEBIDAE—Ce-bus olivaceus;

Insusceptible species: White rat, Bufo viridis; Cercopithecus callithrix; chicken (except embryo).

Geographical distribution: Probably

Induced disease. In man, usually acquired in first three years of life, sometimes as aphthous stomatitis; virus probably retained often through life, sometunes with periodic reappearance of dermai lesions, which are vesicular and heal soon. In white mouse, by experimental inoculation of skin, small inflamed vesicular primary lesions about 5 days after moculation, usually forming scales and healing a few days later, but sometimes persisting, if on tail, followed by swelling and paralysis of tail, ascending paralysis and death, or by recovery with acquired immunity, if near head, followed by encophalitis and ileath, intraperitoneal and sometimes other inoculations immunize. relapse with recurrence of primary lesions rare In chick embryo, white, opaque, circular or ring like primary lesions of small size on choricallantoic membrane. with or without perotic secondary lesions in liver, heart, lungs, apleen, and

kidneys; virus enters membrane 1 to 4 bours after it is dropped on its surface; primary lessons may be counted in 48 bours.

Transmission: By contacts. Experimentally, by skin scarification; in guinea pig, by feeding.

Serological relationships: Distant relationship to pseudornbies virus, Scelus suillum, shown by moderate protection against this virus conferred by some antiherpes sera. No relationship to vaccinia virus or to virus III of rabbits demonstrable by neutralization tests. Specific complement fixation. Neutralizing antibody forms reversible union with virus, at least for a time, though with strong mutures partial irreversibility finally occurs.

Immunological relationships: Formalinized virus and non-lethal strains of virus immunity specifically. No cross immunity with vaccina virus.

Thermal mactivation: At 50 to 52° C in 30 minutes, when moist, at 90 to 100° C in 30 minutes, when dry. At 41 5° C in 50 to 80 hours.

Filterability Passes Berkefeld V filter with shight loss.

Other properties Diameter, by centrifugation, computed as 180 to 220 mill: microns; by filtration, 100 to 150 millimerons. Specific gravity, 1.15. In-activated by repeated freezing and thrwing, also by pressure of 3000 atmospheres for 30 mnutres. Visible for 30 mnutres. Visible for 30 mnutres. Visible for 30 mnutres. Visible for yat least 18 months at 4°C, in 50 per cent glycerine at least 6 months. Not inactivated at 4°C in 1 per cent aqueous gentfun violet. Clurged negatively in subtions of by-drogen on concentration up to about pill 8. Isoelectric point, pill 7.2 to 7.6. In-activated by inculvition in vitro at pill 6 with arthretic vitamin C (ascorbio acid).

Literature Anderson, Science, 20, 1930, 497; Am. Jour. Path., 10, 1910, 137–136, Andersont, Jour. Inf. Dis. 44, 1929, 333–339; 43, 1929, 336–334, 42, 1931, 507–529, Andrews, Jour. Path. and Biet., 37, 1930, 301–312; Bysett et al., Compt. rend. Acad. Sci., Paris, 200, 1935, 1882–1884; Berbold and Schlesinger, Zitefr.

nceks in 50 per cent glycerine and 16 months dried when frozen, and stored on ice.

Literature : Andrewes, Brit. Jour. Exp. Path., 10, 1929, 188-190, 273-280; Jour. Path, and Bact., 33, 1930, 301-312; 50. 1940, 227-234; Rivers and Stewart, Jour. Exp. Med., 48, 1928, 603-613; Rivers and Tillett, tbid., 59, 1924, 777-802; 40, 1921, 281-287; Topacio and Hyde, Am. Jour. Hyg., 15, 1932, 99-124,

5. Scelus ulceris spec. nov. From Latin ulcus, sore spot.

Common name. Ovine balano-posthitis virus.

BOV1DAE-Opis aries Host: sheep.

Geographical distribution: United States, Australia.

Induced disease: In sheep, ulceration with scab production : lesions most severe on prepuce and vulva; in the male, the penis may be involved, usually only with mild inflammation, but if accompanied by naraphimosis there may be extensive ulceration and heavy scab formation,

Transmission: Venereally. mentally, by inoculation of prepuce.

Filterability, Passes Borkefeld N and W filters, a 7 lb Mandler candle, and a 31 per cent collodion membrane.

Literature Tunnicliff and Matisheck, Science, 94, 1941, 283-284,

6. Scelus marmorans spec. nov. From Latin marmorare, to marble, in reference to mottling of spicen and liver in host. Common name, Ectromelia virus.

Hosts: MURIDAE-Mus musculus L., white mouse. Esperimentally, also MURIDAE-Rattus norvegicus (Berkenhout), rat (infection inapparent). Also, PHASIANIDAE-Gallus gallus (L.), chick embryo (12-day-old White Leghern chick embryo at 36 to 37° C; less satisfactory results at higher temperatures of incubation or in embryos in spring eggs to Derived strains of this virus infect rabbit and guines pig, not susceptible to original virus from mouse.

Geographical distribution: England.

Induced disease: In white mouse, spleen mottled, liver edges translucent, peritoneal fluid increased in amount; loss of weight; later, cutaneous lesions on foot or elsewhere; affected foot swells, becomes moist, scabbed, then recovers or dries up and separates from the skin at limit of original swelling; in acute disease, death without gross lesions, or, at autopsy, gut dark red, liver dirty grav, soft, bloodless, sometimes mottled, spleen necrotic; inclusion bodies most numerous in lesions of the skin, round or oval, 4 to 13 microns long, without internal differentiation; very young mice probably become infected without developing anparent disease and remain carriers for some time. In rat, inapparent infection; after initial increase of virus, circulating antibodies appear and immunity to reinfection is established.

Transmission: In mouse, by contact. In rat, experimentally, by intranssal incentation.

Serological relationships: Neutralizing antibodies occur in convalescent mouse serum. Immune sera from the guinea pig specifically agglutinate elementary bodies obtained from infected skin of the white mouse.

Immunological relationships: Recovered mice are solidly immune to many lethal doses.

Thermal inactivation At 55° C in 30, not in 10, minutes.

Filterability . In broth, passes Mandler, Pasteur-Chamberland L. and Berkefeld N filters

Other properties: Survives drying 6 months, freezing (-10° C) 2 months, 50 per cent glycerine 5 months at least. Resists I per cent phenol 20, not 40, days. Size, estimated by filtration, 100 to 150

45, 1936, 105-120, Jahn, Arch. t. Virusforsch., 1, 1939, 91-103; Kikuth and O. Bang, Acta path, et microbiol, Scand., Suppl., 11, 1932, 180-182; Carini and Maetel, Bull, Soc. Path. exot., 5, 1912, 576-578: Folger, Acta path, et microbiol. Seand., Suppl., 11, 1932, 182-187; Glover, Brit. Jour. Exp. Path., 20, 1939. 159-158. Gowen and Schott, Am Jour. Hye., 18. 1933, 674-687, Hurst, Jour. Exp. Med , 58. 1933, 415-433, 59, 1934, 729-749; 65. 1936, 419-463, Koves and Hirt, Arch. missensch u. prakt. Tierheilk., 68, 1931, 1-23 Morrill and Graham, Am. Jour. Vet. Res. 2, 1941, 35-40; Brit. Jour. Exp. Path., 15, 1931, 372-380; Shope, Proc. Soc Exp. Biol. and Med., 50, 1932, 305-309 Jour. Exp. Med., 54, 1931, 233-218; 67, 1033, 923-931, 62, 1935, 85-89, 101-117, Traub, abid . 58, 1933, 663-681; 61, 1935. 833-838

3. Scelus beta spee, nov. From beig. second letter of Greek alphabet, in reference to common name.

Common name B virus

Hosts HOMINIDAE-Homo sopiens L. man. CERCOPITHECIDAE-Macaca mulutto (Zimmermann), rhesus monkey Experimentally, also LEPOR-IDAE-Oryclologus cunteulus (L), rab-CAVIIDAE-Carra porcellus (L.). hit cuinca mg

Geographical distribution -Umited States (from captive monkeys and man)

Induced disease. In man, local and relatively insignificant lesion on bitten part, later flaverd paralysis of legs, urmary retention, ascending paralysis, and death by resparatory failure. In Moraca mulatta experimentally by intraculaneous maction, hemorrhagic or sesiculo pustuiar lessons without later involvement of central nervous system but with subsequest acquired immunity. Acidophilic intranuclear inclusions in lesions. Transmission To man, by bite of mon-

key To monkey, experimentally, by

iniction

Laterature Burnet et al., Austral, Jour. Exp Biol and Med Sci., 17, 1939, 35-40, 41-51, Saban, Bent, Jour, Exp Path., 15. 1931, 215-268, 265-279, 321-331; Sabin and

Hurst, shid., 16, 1935, 133-148; Sabin and Wright, Jour. Exp. Med., 59, 1931, 115-136

4. Scelus tertium spec. nov. From Tatin terties, third.

Common name: Virus III of rabbits. Host LEPORIDAE-Oryctologus cunuculus (L ), domestic rabbit.

Insuscentible species. No obvious disease in inoculated guinea pig, white mouse, monkey (Macaca mulatta Zimmermann), rat, or man, hence the assumption that these are naturally immune, but they may be merely tolerant or Mendusie.

Geographical distribution: States (apparently spontareous in some individuals of the laboratory rabbit).

Induced disease. In domestic rabbit. experimentally, after incubation period of 4 to 6 days, failure to eat, loss of weight, occasionally diarrhea and temperatures of 101 to 107° F; small, superficial, red spots and papules on skin at site of inoculation, local infideration of tissues with endothelial leucocytes, swelling of involved enathelial cells; nuclear inclusions present in endothelial leucocytes and some other cells; disease not fatal; virus in circulating blood only during early stages, recovery in a few days without scar formation but with development of specific immunity The course of the natural disease, presumed to occur in rabbits, is still unknown

Transmission Experimentally, by inrection of filtrates from diseased tissues. on several occasions also from blood or tissues of apparently normal rabbits.

Serological relationships Specific neutraining substances occur in the serum

of recovered rabbits. Immunological relationships: Specific immunity but no cross reactions with

vaccinia or heroes viruses. Thermal inactivation. In 10 minutes at

55° C, but not in 30 minutes at 45° C. Filterability, Passes Berkefeld V and

N filters, passes La filter candle. Other properties: Viable at least 6 in vacuo, at least a week at -4 to 0° C. Readily destroyed by 1 to 2 per cent sodium hydrate or above pH 11. Soon inactivated near pH 6.0, but moderately stable at pH 2.0 to 3.0; optimum condition for storage at pH 7.5 to 7.7 in absence of air; return from 3.0 to 7.5 inactivates, however.

Literature : Elford and Galloway, Brit. Jour. Exp. Path., 18, 1937, 155-161; Galloway and Elford, thid., 14, 1933, 400-408, 16, 1935, 588-613; 17, 1936, 187-204; Galloway and Schlesinger, Jour. Hyg., 57, 1937, 463-470; Hare, Jour. Path. and Bact., 55, 1932, 291-293; Loeffler and Frosch, Cent. f. Bakt., I Abt., 25, 1898, 371-391, Matte and Sanz, Bull, Soc. Path. Exot., 14, 1921, 523-529; Oliisky and Boez, Jour. Exp. Med., 46, 1927, 673-683, 685-699, 815-831, 833-848; Pyl, Ztsehr. f. physiol. Chemie, 226, 1934, 18-28; Pyland Klenk, Cent. f. Bakt., I Abt., Orig., 128, 1933, 161-171; Schlesinger and Galloway, Jour. Hyg., 37, 1937, 445-462.

2. Hostis equinus spec. nov. From Latin equinus, pertaining to horses.

Common names: Vesicular-stomatitis virus, equine vesicular stomatitis virus.

Hosts. Horse, domestic cattle. Experimentally, also guinea pig, swine, white mouse, rabbit (rolatively resistant), chick embryo; Macaca mulalta (Zimmermann), rhesus monkey, M. rrus, expomologus monkey.

Insusceptible species: Chicken (except embryo).

Ceographical distribution: United States (Indiana, New Jersey).

Induced disease. In horse, resembles foot-and-mouth disease of eatitle; red-dened patches on buccal mucosa, moderate fever, salivation, followed by appearance of vesicles, especially on tongelled with clear or yellowish fluid; vesicles often coalesce and soon rupture leaving an eroded surface which heals soon in the absence of complications,

Experimentally, in choricallantois of developing chick embryo, primary lesions involve moderate ectodermal proliferation, degeneration, necrosis; mesodermal inflammation; slight endodermal proliferation.

Serological relationships: Strains isolated in different localities give antisers capable of neutralizing heterologous isolates of virus, but homologous antisers neutralize in higher dilutions than do heterologous nntisers.

Immunological relationships: No cross immunity with respect to equine encephalomyelitis virus.

Filterability: Passes Seitz filter.

Other properties: May be separated from mixtures with foot-and-mouth disease virus by propagation on choricallantoic membrane of chick embryo, which will not support increase of the latter virus. Inactivated by 1:50,000 methylene blue in 2 mm layer 13 cm from 300 candle-power lamp in 00 minutes but not in 20 minutes. Particle estimated on the basis of filtration data to be 70 to 10 millimiterons in diameter; 60 millimiterons in diameter by centrifugation. Not destroyed by acidifying to pH 3 and returning to pH 7.5 (difference from foot-and-mouth disease virus).

mount users of the process of the pr

Gönnert, Arch. f. Virusforsch., I, 1940, 293-312, Marchal, Jour. Path. and Bact., 28, 1930, 713-728; McGonghey and Whitehead, rbid., 57, 1933, 253-250; Parchen, Cent. f. Bakt., I Abt., Orig., 135, 1936, 415-452

7. Scelus bovinum spec. nov. From Latin bovinus, of ox, buil, or cow.

Common name Erosive stomatitis

Rost BOVIDAE-Bos taurus L., domestic cattle, Experimentally, also choroallantoic membrane of developing hen's egg.

Insusceptible species. CAVIIDAE— Catia percellus (L.), guinea pig. (In rats, rabbits, mice, sheep, no reaction has been noted after moculation.)

Geographical distribution South Africa (Natal); perhaps Ireland (Armagh-disease virus).

Induced dracase In young domestic

cattle, lesions on tongue, dental pad, and lips pear-like at first, then breaking down to form superficial erosions, with white glistening base and red border. Lesions may coalesse to form large, ragged, cruded areas, healing uneventfully with sear formation. No foot lesions; no excessive salivation, no "hotness" of mouth; no systeme disturbances.

Transmission. Spreads slowly, mainly to atimals less than three years old, probably by contact. Experimentally, by angetion into dental pads, lips, or tongue. Pilterability. Passes Gradocol membrane of about 400 millimureron average pore disputer.

Other properties, Viable after at least 11 days at room temperature, 21 days at refrigerator temperature, 6 weeks frozen and dried in horse-serum saline.

Laterature: Mason and Neitz, Onderstepoort Jour. Vet. Sei, and Anim. Indust., 18, 1940, 159-173.

# Genus IV. Hostis gen. nov.

Viruses of the Foot-and-Mouth Disease Group, inducing diseases mainly characterized by vesicular lesions Generic name from Latin hostis, enemy or atronger. The type species is *Hostic pecess spec mor* 

## Key to the species of genus Hostls.

- Infecting cattle and other animals with cloven hoofs; horse immune or highly resistant.
- II Infecting horse readily
- Ilostis pecoris spec, nov. From lain pecus, cattle.
  Common names Foot and-mouth dis-
- tase virus, Virus der Maul- und Klauenseuche.

Hoste Caw, pg, sheep, goat, remieer, hoste Experimentally, also guinea pg, rabbit, rat.

Insusceptible species. Chick embryo (chornellimins), horse (immune or very resistant).

Induced disease. In cow, after incubation period of 2 to 4 days or more, fever, concular lessons on tongue, lips, guins, hard polite and feel, when rupturing, solvetion, lameness, generally recovery 1. Hostis pecorie.

2. Hostis equinus,

Transmission Spread rapid, source of infection often obscure, saliva is infective before lesions become obvious.

Thermal mactivation At 76° C, not at 60° C, in 15 minutes.

Filterability Passes Seatz, Berkefeld V and N, and Chamberland Let filters. Strains Three strains, A, O and C, are immunologically itetinet from each other.

Other properties Particle calculated to be about 20 millimicrons in diameter by centraligation data, 8 to 12 millimicrons in diameter by filtration, may be separated from mixtures with the larger equive according tomatities virus by differential filtration. Viable after drying

1905, 1508-1509; Lipschütz, Arch. Dermat. u. Syph., 107, 1911, 387-396; in Kolle, Kraus and Uhlenhuth, Handbuch der Pathogenen Mikroorganismen, 8, 1930, 1031-1040; Van Rooyen, Jour. Path. and Bact., 46, 1933, 425-436; 49, 1939, 345-340; Wile and Kingery, Jour. Cutan. Dis., 37, 1919, 431-446.

3. Molitor bovis spec. nov. From Latin bos, cow.

Common name: Cattle-wart virus.

Host: BOVIDAE-Bos tourus L., domestic cattle.

Geographical distribution: United

Induced disease. In cattle, especially about head, neck, and shoulders in young animals, on udders in cows, affected skin thickened at first, then rough, nothlar; warts sometimes become large and pendulous, adversely affecting growth of host; they sometimes become caudiflower-like tumors several inches in diameter; spontaneous regression is not infrequent. Hides from affected animals are reduced in value.

Transmission: Believed to be through injuries to skin when the injuries to receive the injuries to receive the injuries to receive the injuries to receive the warty animals of with rubbing posts, chutes, fences, buildings, or other structures with while infected animals have come in contact previously. Experimentally, by skin inoculations, especially in animals under 1 year of acc.

Filterability: Passes Berkefeld N filter. Literature: Creech, Jour. Agr. Res., 59, 1929, 723-737, U S. Dept. Agr., Leaflet 75, 1931, 1-4.

4. Molitor buccalls spec. nov. From Latin bucca, cheek.

Common name Camme oral-papillomatosis virus.

Host: CANIDAE-Cans familiaris

Insusceptible species Cat, rabbt, guinea pig, rat, mouse, Macaca mulatta (Zimmermann), rhesus monkey.

Induced disease: In young dog, experimentally, about I month after inoculation of buccal membrane by scarification,

pale, smooth elevations, becoming gradually more conspicuous and roughened; finally a mass of closely packed papillae is formed. Regression with subsequent immunity is frequent; no sears are left on regression. Secondary warts often appear in other parts of the mouth 4 to 6 weeks after primary warts have first been observed.

Transmission: Experimentally by skin scarification.

Scrological relationships: Not inhibited by antiserum effective against commonwart virus of man.

Thermal inactivation: At some temperature between 45 and 58° C in 1 hour. Filterability: Passes Berkefeld N filter.

Other properties; Viable after freezing and drying, if stored dry in icebox, at least 63 days; in storage in equal parts of glycerine and 0.9 per cent NaCl solution at least 64 days.

Literature: DeMonbreun and Goodpasture, Am. Jour. Path., 8, 1632, 43-66; MFadyean and Hobday, Jour. Com. Path. and Therap., 11, 1898, 341-344; Penberthy, 1614, 11, 1893, 363-365.

5. Molitor tumoris spec. nov. From

Latin tumor, swelling, Common names: Fowl-sarcoma virus, Rous chicken-sarcoma virus.

Hosts: PHASIANIDAE—Gallus gallus (L.), chicken. Experimentally, also phensant (serial transfer difficult) and duck (by cell transfer only but filtrates from duck infect injected chicken).

Insusceptible species: Turkey, guines fowl (both immune to filtrates but capable of supporting tumor line if alternated in a series with common fowl hosts);

geese.

Induced disease: In hen, originally found in an adult, pure-bred hen of Barred Plymouth Rock variety. Experimentally transmitted, a circumseribed module soon becomes evident at site of implantation; later this becomes necroite or cystic at its center; as growth enlarges, host becomes emacasted, cold, somnolent, and finally dies; discrete metastases are often found in lungs, heart, and liver. Parent cell of sarcomn is claimed to be

## Genus V. Molitor ven. nov.

Viruses of the Wart-Disease Group, inducing diseases mainly characterized by tissue proliferation without vesicle or pustule formation. Generic name from Latin molifor, contriver.

The type species is Molitor verrucae spec. nov.

## Ken to the species of genus Mollton.

- I. Affecting man.
  - 2 Molder hominis.
- 11. Affecting cow.
- III. Affecting dog.
- IV. Affecting chicken.
- V. Affecting rabbit
- ! Molitor verrucae spec. nos. From Latin perruea, Wart.

Common name . Common-wart virus. Hosts · HOMINIDAE - Homo saniens L., man. Perhaps also BOVIDAE-Box taurus L., cow. CANIDAE-Canis familiaris L , dog.

Induced discase. Experimentally in man, incubation period long, 4 neeks to 6 or more months, initially acanthosis forcerowth of prickle cell layer of epidermis) and flattening of the popillae. later, interpapillary hypertrophy, inflammation, and marked hyperkeratosis

Transmission By contact, in some eases, venereally. Experimentally, by skin scar fication.

I dierability . Paxses Berkefeld N filter Literature Ciuffo, Giorn, ital. d. malattie venerce e d. pelle, 48, 1907, 12-17 . Kingery , Jour Am. Med. Assoc , 76, 1921, 410-412, Payne, Brit. Jour. Dermat . 3, 1601 185-188, Schultz, Deutsch, med. Wehnschr , 54, 1908, 423; Serra, Gorn. ital d maistive venerce e d. pelle, 65, 1921, 1508-1814, Ullmann, Acta otolary ngologica, 5, 1923, 317-331. Wife and hingery, Jour Am. Med. Assoc., 75, 1919, 970-973.

2. Molitar hominia comb. (Strong loplasma kominis Lipschütz,

1. Register verruege.

3. Mehter borie.

4. Molitor buccalis.

5 Mobiler lumeris.

G. Molitor gingicalis.

7 Molitor sulvilage.

8. Mclitor myzomae.

Arch Dermat, u. Syph., 107, 1911, 305 ) From Latin home, man.

Common name: Molluscum contagiosum virus.

Most: HOMINIDAE-Homo sapiens L. man.

Geographical distribution. Perhaps escentially world wide.

Induced disease. In man, experimentally, prodromal period may be 14 to 50 days, lesions at first like numples, becoming red, painful, anollen, developing into small tumors covered with stretched and shipy skin; lesions commonest on face. erms, buttocks, back, and sides, healing apontaneously. Inclusions within epithelial cells, known as móliuscum bodies, measure 6 to 21 microns in diameter when approximately spherical, 21 to 27 microns in width and 30 to 37 microns in length when elongated, they contain elementary bodies about 0.3 micron in diameter. The outer envelope of the molluseum body is of carbohydrate.

Transmission. By contact. By fomites

Filtershilay: Passes Chamberland L. and Berkefeld V filters.

Literature: Goodpasture and King. Am, Jour. Path., 5, 1927, 385-391; Goodpasture and Woodross, shid., 7, 1931, 1-6; Juliusberg, Deutsch, med. Wehnschr., Erxleben, snowshoe hare; L. californicus Gray, jack rabbit; Sylvilagus sp., cottontail rabbit.

Geographical distribution: United States.

Induced disease: In rabbit, benign papillomas, having the form of small, discrete, gray-white, sessile or pedunculated nodules, usually multiple, on lower surface of tongue or, less frequently, on sums or floor of mouth.

Transmission: Perhaps by mother to auckling young, with a latent period before onset of disease. Not highly contagious, if contagious at all, in old animals, Experimentally by puncture of tissues in the presence of tirus.

Immunological relationships: Specific immunity develops as a result of disease, but no cross immunity with respect to rabbit-papilloma virus, which differs also in failing to set on oral mucosa.

Filterability: Passes Berkefeld V and

N filters.
Literature: Parsons and Kidd. Jour.

Exp. Med., 77, 1943, 233-250.

7. Molitor sylvlings epec. nov. From

 Molitor sylvilagi spec. nov. From New Latin Sylvilagus, generic name of cottontail rabbit.

Common names · Rabbit papilloma or papillomatosis virus, rabbit wart virus.

Hosts: LEPORIDAE—Sylvilagus sp., cottontail rabbit. Experimentally, also LEPORIDAE—Oryctolagus cuniculus (L.), domestic rabbit.

Geographical distribution: United

Induced disease In cottontal rabbit, at first minute elevations along lines of scarafication; later sold marces of wrinkled keratinized tissue, 3 to 4 millimeters in thickness, eventually coraffed warts, striated perpendicularly at top, fleshy at base, 1 to 1.5 cm in height; regression rare, natural papillomas become malignant occasionally. In domestic rabbit, experimentally, blood antibody remains low but virus is always masked, prevening serial passage, discrete lesions on skin permit quantitative tests, tarring causes

localization of virus from blood stream: bapillomas give rise to malignant acanthomstous tumors by graded continuous alteration; metastasis frequent; transplantation to new hosts successful in series; natibody specific for the virus is formed continuously in the transplanted growths although virus is not directly demonstrable by subinoculation from them; malignant growths appear more promptly and frequently where epidermis has been tarred long; virus appears specific for epithelium of skin; emuthe disappear if treated with X-rays, 3600 r at one time or fractionally; 60 per cent are cured with 3000 r. but 2000 r ineffectiva

Transmission: Experimentally, by scarification of skin. Abnormal susceptibility to infection is noted in rebbit skin treated with 0.3 per cent methylcholanthrene in bonzene or equal parts of turpenting and acctone.

Sepological relationships: Specific neutralization, reversible on dilution. Complement fixation specific, with virus particle as satigen; no cross reaction with antisera for vaccinia, herpes, fibroma, or myxoma viruses. Precipitates occur in properly balanced mixtures of virus and specific antiserum; virus and antibody in both free and neutralized states are present in both soluble and insoluble phases of these suspensions.

primeres of these suspensions. Intraperitoneal injections immunize specifically. Rabbits immunized to fibroma and myxoma viruses are susceptible to rabbit papilloma virus.

Thermal inactivation: At 70° C, not at 65 to 67°C, in 30 minutes; in 0.0 per cent sodium chloride solution at 65 to 60° C, time not stated.

Filterability: Passes Berkefeld V, N, and W filters; partiels sire calculated as 23 to 35 millimicrons by filtration as compared with 32 to 50 millimicrons by centrilugation and 44.0 millimicrons by measurement of electron micrographs; which show the partiels to be approxi-

mately spherical in shape,

the normal histiceyte, but wrus in the affected fowl is not confined to the sarcoma, being widespread in the body in spleen, liver, muscle, brain, etc. In the chick embryo, serial passage is feasible on the egg membrane, in which focal lesions involve only ectodermal tissue.

Transmission. By injection of affected foul cells or filtrates. Certain transmissible tar-finduced sereomas, not infecting by filtrates, nevertheless induce the formation of antibodies capable of neutralizing this virus. An inhibitor of the virus extracted from tumors appears to be a profesion, inactivated at 65° C, but not at 55° C, in 30 minutes and destroyed by trypin in 3 to 5 hours at pHs. Obec acid also may act as an inhibitor. No apontaneous transmission in chickens kent together.

Scrological relationships: Particles sedimented by centrifugal force 20,000 to 30,000 times gravity are specifically agglutinated by sera of lowls bearing corresponding tumor. At least one antigen in tumors of hen and duck not in healthy hirds, this one fixes complement and gives cross reactions with Rous, Mill Hill 2, Fujinami, and RFD2 tumors, Virus injected into goats produces two antibodies but only one if previously heated, the antibods to the heat-stable constituent requires complement to neutralize virus, the only antibody produced in ducks does not require complement to neutralize

Thermal inactivation: At or below 51° C in 20 minutes.

Filterability Passes Berkefeld V and no 5 (medium) filters.

Other properties Particle size estimated as about 100 millimicross (but some say 50 or even 15 millimicross) in dameter by filtration through graded membranes, about 70 millimicross (molecular weight 140,000,000) by ultracentrifugation Contains 85 to 90 per cent natiopen, 12 per cent phosphorus. Protein testa pairies Fedgen restation for thymonucleic acid absent, 10 to 15 per cent of the protein may be nucleic

acid, probably of ribose type. Pentose present. Virus believed to be of globulin nature or attached to globulin particles (Lewis and Mendelsohn, Am. Jour. Hyg., 12, 1930, 688-689). Viable indefinitely in dried spleen as in dried sarcoma tissues.

Strains: Several strains have been studied in addition to the original Rous serroma no. 1 strain; immunological relationships have been shown between the original strain, the des Ligneris sarcoma strain, the Fujinami sarcoma strain, the fibreasroma MHI and endothelioma MH2 strains, other Isolates also have shown serological interrelationships.

Laterature: Amues, Jour. Path, and Bact., 44, 1937, 141-166; Amjes et al., Am. Jour. Cancer, \$5, 1939, 72-79; Andrewes, Jour. Path, and Bact., 34, 1931, 91-107; 35, 1932, 407-413; 37, 1933, 17-25, 27-41, 43, 1936, 23-33; Claude, Jour. Exp. Med., 66, 1937, 59-72; Science, 87, 1938, 467-468; 90, 1939, 213-214; Am. Jour. Cancer, 37. 1939, 59-63, Claude and Rothen, Jour. Exp Med., 71, 1910, 619-633, Dinnehowski and Knov, Brit. Jour Exp. Path., 20. 1939, 466-472, Elford and Andrewes. ibid., 16, 1935, 61-66; Gye and Purdy, Jour. Path. and Bact., \$4, 1931, 116-117 (Abst.); Haddow, abid , 37, 1933, 149-155; Helmer, Jour. Exp. Med., 64, 1936, 333-339, Keogh, Brit. Jour Txp. Path., 19. 1938, 1-9, Ledingham and Gye, Lancet, 228, 1935 (1), 376-377, Lewis and Mendel-ohn, Am. Jour. Hyg., 12, 1930, 686-699, des Ligneris, Am. Jour. Cancer, 16. t932, 307-321, McIntosh, Jour, Path, and Bact , 41, 1935, 215-217, Mellanby, Jour. Fath. and Bact , 46, 1938, 447-460; 47. 1938, 47-61, Mendelsohn et al., Au., Jour. Hyg., 14, 1931, 421-425, Purdy, Brit. Jour, 1:xp Path., 13, 1932, 173-479 Rous, Jour. Exp. Med., 15, 1911, 397-111.

6. Molitor gingivalis spec. nor. From Latin gingire, gum.

Common name: Rabbit oral-papilloma-

Hosts. LEPORIDAE-Oryclologus cunsculus (L.), domestic rabbit. Experimentally, also Lepus americanus Rods: 1.0 hy 1.0 to 3.0 microns, necurring singly and in pairs. Motile with one to five polar flagella. Gram-negative. Gelatin colonies: Circular, white with

buff center, convex, smooth, undulate. Gelatin stab: No liquefaction.

Agar colonies: Circular nr amoeboid, white to buff, flat to convex, smooth,

entire.
Agar slant: Filiform, pale buff, raised,

smootb, undulate. Broth: Turbid.

Nitrites not produced from nitrates. Starch not hydrolyzed.

No acid in carbohydrate media.

Attack phenol and m-cresol.

Aerohic, facultative.

Optimum temperature 30 to 35°C.

Hahitat : Soil.

42. Pseudomonas rugosa (Wright) Chester. (Bacillus rugosus Wright, Memoirs Nat. Acad. Sci., 7, 1895, 438; not Bacillus rugosus Henrici, Arb. Bakt. Inst. Tech Hochsch. Karlsruhe, 1, 1894, 28; nnt Bacillus rugosus Chester, Determinative Bacteriology, 1901, 220, Chester, Determinativo Bacteriology, 1901, 223.) From Latin, rugosus, wrinkled. Small rods, with rounded ends, occur-

ring singly, in pairs and in chains. Motile, possessing one to four polar flagella.

Gram-negative.

Gelatin colonies: Grayısb, translucent, slightly raised, irregular, ainuous, radiately erose to entire

Gelatin stah: Dense, grayısb-green, limited, wrinkled, reticulate surface growtb. No liquefaction.

Agar slant: Grayisb-white, limited, slightly wrinkled, translucent.

Broth: Turbid, with grayisb pellicle and sediment.

Litmus milk: Acid, coagulated.

Potato: Moist, glistening, brown. Indole is formed.

Nitrites not produced from nitrates.

Acrobic.

Optimum temperature 30°C.

Habitat: Water.

43. Pseudomonas desmolyticum Gray and Thurntan. (Gray and Thornton, Cent. f. Bakt., II Abt., 73, 1928, 90; Achramobacter desmolyticum Bergey et al., Manual, 3rd ed., 1930, 217.) From Greek desmos, bond, hand; lytikos, able to dissolve.

Rods: 0.7 to 0.8 by 2.0 to 3.0 microns, necurring singly and in pairs. Motile, with one to five polar flagella. Gram-

negative.

Gelatin colonies: Circular, gray to buff, raised nr umbonate. Smooth, glistening, entire.

Gelatin stab: No liquefaction.

Agar colonies: Circular or amoeboid, whitish, flat or convex, smooth, translucent to opaque, entire.

Agar slant: Filiform, palo huff, raised, smooth, undulate.

Broth: Turbid.

Nitrites produced from nitrates. Stareh not hydrolyzed.

Acid from glucose.

Attnck phenol and naphthalene. Aerohic, facultative.

Optimum temperature 25°C. Habitat: Soil.

44. Pseudomonns rathonls Gray and Thornton. (Gray and Thornton, Cent. f. Bakt., II Abt., 73, 1923, 00; Achromobacter rathonis Bergey et al., Manual, 37d, 216.) From M. L. of Rathn Park (Edinburgh).

Small rods: 0.5 to 1.0 by 1.0 to 3.0 microns. Motile, with polar flagella. Gram-negative.

Gelatin colonies: Gircular, white, raised, smooth, glistening, undulate.

Gelatin stab: No liquefaction.

Agar colonies: Gircular, buff, flat,

smooth, glistening, entire.

Agar slant; Filiform, pale buff, convex,

smooth, glistening, undulate.

Broth: Turbid, with pellicle. Nitrites produced from nitrates.

Starch bydrolyzed.

Acid from glucose and glycerol.

Other properties: Infectious particle has sedimentation constant S<sub>11</sub> = ca. 250 × 10<sup>-11</sup> cm per sec. per dyne; usually there is a secondary boundary at about 375 × 10<sup>-11</sup>. Isoelectric point between pH 4.8 and 5 1. Maximum absorption at about 2750 Å. Contains thymus nucleic acid about 6.8 to 8.7 per cent; maximum absorption of nucleic seid at about 2800 Å.

Literature · Beard et al., Jour. Inf. Dis. 65, 1939, 43-52, 69, 1941, 173-192, Bryan and Beard, 161d., 65, 1939, 306-321, Friedenald, Jour. Exp. Med , 75, 1912, 197-220, Hoyle, Jour. Path, and Bact., 50, 1910, 169-170, Kidd, Jour, Exp. Med., 68, 1939, 703-724, 725-759, 70, 1939, 583-601, 71, 1910, 469-491, 74, 1911, 321-311, 75, 1912, 7-20; Kidd and Rous, abid., 68, 1938, 529-502, 71, 1910, 813-838, Kidd et al., toid., 64, 1936, 63-77, 79-96, Rous and Beard, ibid , 60, 1934, 701-722, 62, 1935, 523-518: Rous and Kidd, shid., 67, 1938. 399-428, 71, 1910, 787-812; Rous et al . abid. 64, 1936, 385-400, 401-121, Schlesinger and Andrewes, Jour. Hyg., 57, 1937, 521-526, Shwp et al., Proc. Soc. Exp Biol and Med , 50, 1912, 203-207, Shope, Jour Lan Med., 58, 1933, 607-621. 65, 1937, 219-231, Syverton et al., soid , 75, 1941, 243-218, Taylor et al., Jour Inf Dis , 71, 1912, 110-114,

8 Molitor myxomae (Aragão) comb. nor. (Chlamidoroon myzomae Aragão, . Brazil Med . 25, 1911, 471, name later abandoned by its original author in favor of Strongyloplasma myzamae Aragão. Mem Inst. Oswaldo Cruz, 20, 1927, 231 and 213 The name Sonarclin currents Lipschütz, Wien klin, Wochenschr., 40, 1927, 1103, was bestd on the supposed cau-ative organism, defined as varying in size between the size of chlamydozon and of large cocet. It is not clear whether the structures observed and named sere virus particles or not } From New Latin muzoma, a kind of roll tumor, from asture of induced brains

Common names: Myxoma virus, riruz

Hosts: LEPORIDAE—Oryclolagus euniculus (L.), domestic rabbit. Experimentally, also Sylilagus sp., cottontail rabbit; jack rabbit (once in many trals), Lepus brasiliensis (resistant and rarely infected). Also chick embryo and duck embryo.

Insusceptible species: Lepus califormeus Gray, black-tailed jack rabbit; L. americanus Erdeben, varying hare; Sylrilagus transitionalis Bangs, cottomtali; horse, sheep, goat, catile, dog (but one reported infected), gunca pp;, rat, mouse, foul, pigeon, duck, cat, hamster, monkey; man (but some conjunctival pain and swelling).

Geographical distribution : South America (Brazil, Uruguay, Argentina), United States (California).

Induced disease: In domestic rabbit, a disease (muzomolosis euniculi) almost always fatal at ordinary room temperatures but not at 36 to 42° C. lessons fewer and regressing after 6 to 8 days at these higher temperatures in most animals. At ordinary temperatures, nodules (edematous tumors) in skin near eyes, nose, mouth, ears, and genitalia; edema of evelida; conjunctivitie with purulent discharge if ship around eyes is involved. Later marked dysphen, stertorous breatling, evanosis, asphyxia. Animals usually die within 1 to 2 weeks of infection. Virus enters bloodstream and invades nervous system at random through nalls of blood vessels. Discharges from nose, eves, and the serous exudates from affected tissues are infectious, urine and feces are not. There are evigolasmic inclusions to alfeeted epidermal cells. In chick embryo, experimentally, intense inflamma. tion, eventual importment of circulation and pecrosis locally, growth best if embryo is grown at 33 to 35° C and chilled to 25° C for 12 to 18 hours before or after inoculation, lesions being linear and assoerated with capillaries in ectoderm; virus infects and is recoverable from embryo and depresses hatch.

Transmission. By contact with dis-

by them. Through air for a few inches. Rarely by feeding. Experimentally, by rubbing conjunctiva with a bit of infected tissue or with a platinum loop contaminated from diseased conjunctiva; has been recovered from files. By injection. By flea, Ctenopsylla felis (PULICIDAE), rarely.

Scrological relationships: An attack of the disease induces the formation of neutralization by antisora to mynoma and fibroma strains. Complement is fixed with mynoma virus as test antigen in the presence of antisora to mynoma or fibroma strains. Serum of rabbut inoculated with a coluble antigen, a heat-labile protein with so-clectric point near pH 4.5, agglutinates mynoma elementary bodies. A second soluble antigen, also heat labile, appears dustinct, inhibiting its own antibody even after i mactivation of its precipitating power by exposure at 50° C.

Immunological relationships: My-comarecovered domestic rabbits become immune to reinfection, fibroma-strain-recovered animals, although partially immunized, still support my-comastically immunized at the support of the strength of the strainset valued virus (60° C for 30 minutes) tends to immunized signer intradermally, there is then an allergic local response, less severe generalized disease, delayed death or recovery. If fibroma virus precedes mysoma virus by 48 to 96 hours, there is marked protection.

Thermal inactivation. At 56° C in 10 minutes, at 50° C in 1 hour Assubstance thermostable for 30 minutes at 60 to 75° C, but not at 90° C, is itself unable to produce myvomatous changes after the heat treatment but may do so in combination with fibroma virus, and transmissible myxoma virus is then reconstituted. Although it is supposed by some that this indicates the transformation of fibroma-strain virus into myxoma-strain virus, the possibility that heat-modified myxoma-strain virus is reactivated has not been eliminated.

Filterability: Passes Berkefeld V and N filters; not Chamberland L<sub>5</sub> or L<sub>7</sub> filters.

Other properties: Inactivated above pH 12.0 and below pH 4.0. Withstands drying. Viable at least 3 months at 8 to 10° C.

10° C. Literature: Aragão, Brazil-med., 25. 1911, 471; Mem. Inst. Oswaldo Cruz, 20, 1927, 225-235; Berry and Dedrick, Jour. Baet., \$1, 1936, 50-51 (Abst.); Berry and Lichty, 161d., 31, 1936, 49-50 (Abst.); Berry et al., Second International Congress for Microbiology, Report of Proceed. ings, London, 1936, 96 (Abst.); Fisk and Kessel, Proc. Soc. Exp. Biol. and Med , 29, 1931, 9-11; Gardner and Hyde, Jour. Inf. Dis., 71, 1942, 47-49; Hobbs, Am. Jour. Hyg., 8, 1928, 800-839; Science, 73. 1931, 94-95; Hoffstadt and Omundson, Jour. Inf. Dis., 68, 1941, 207-212; Hoffstadt and Pilcher, Jour. Bact., \$5, 1938. 353-367, 39, 1040, 40-41; Jour, Inf. Dis., 64. 1939, 208-216; 65, 1939, 103-112; Hoffstadt et al., ibid., 68, 1941, 213-219; K. E. Hyde, Am Jour. Hyg., 23, 1936, 278-297; R. R. Hyde, abid., 50 (B), 1939, 37-48, 47-55; Hyde and Gardner, abid., 17, 1933, 446-465; 30, (B), 1939, 57-63; Kessel et al., Proc. Soc. Exp. Biol. and Med., 28, 1931, 413-414; Lipschütz, Wien, klin, Wohschr., 40, 1927, 1101-1103; Lush, Austral. Jour. Exp. Biol, and Med Sci., 15, 1937, 131-139; 17, 1939, 85-88; Martin, Austral. Counc. Sci. and Indust. Res., Buil. 96, 1936, 28 pages; Moses, Mem. Inst. Oswaldo Cruz, 3, 1911, 46-53, Parker and Thompson, Jour. Exp. Med., 75, 1942, 567-573; Plotz, Compt rend. Soc. Biol., Paris, 109, 1932, 1327-1329; Rivers, Jour. Exp. Med., 51, 1930, 965-976; Rivers and Ward, ibid., 66, 1937, 1-14; Rivers et al., ibid., 69, 1939, 31-48; Sanarelli, Cent. f. Bakt., I Abt., 25, 1898, 865-873; Shaffer, Am. Jour. Hyg., 54 (B), 1941, 102-120; Shope, Jour. Exp Med., 56, 1932, 803-822; Smadel et al., ibid., 72, 1940, 129-138; Splendore, Cent. f. Bakt., J Abt., Orig., 48, 1909, 300-301; Stewart, Am. Jour. Cancer, 15 Suppl.,

1931, 2013-2028; Swan, Austral. Jour. Exp. Biol. and Med. Sci., 19, 1941, 113-115.

Strains and substrains: A strain from cottontail rabbits (Sulvilgous sp. ), differing from typical myxoma virus, has been studied extensively under the name fibroma virus. This strain in turn is recognized as consisting of variants and has been investigated as typical (OA) and inflammatory (IA) substrains, antigenically alike but the latter tending to peneralize in domestic rabbits. Fibroma virus is not lethal in domestic rabbits as the type strain almost always is: it appears to lack some anticonic constituents, inducing the formation of acchutining that give cross reactions with the type but of neutralizing and complementfixing antibodies that do not. The fibroma strain does not generally appear in the blood stream, as my yoma virus does, and is not contagions, at least it does not aprend apontaneously among domestic rabbits as the myxoma strain does: the manner of its spread in wild rabbits in pature is not known. Its particle size has been calculated as 126 to 141 millimicrons by centrifugation. 125 to 175 millimicrons by filtration. (Abletram, Jour. Path, and Bact., 46. 1938 461-472: Andrewes Jour, Exp. Med .. 63, 1936, 157-172; Hoffstadt and Pilcher, Jour. Inf. Dis., 68, 1941, 67-72; Hurst, Brit, Jour. Exp. Path., 18, 1937, 1-30; Austral, Jour. Exp. Biol. and Med. Sci., 16, 1935, 53-64, 205-208; Hyde, Am, Jour, Hyg., 24, 1936, 217-226; Ledingham, Rrit. Jour. Exp Path., 18, 1937, 436-449; van Rooyen, ibid., 19, 1938, 156-163; van Rooven and Rhodes, Cent. I. Bakt., I Abt., Orig., 142, 1938, 149-153; Schlesinger and Andrewes, Jour. Hyg., 57, 1937, 321-526; Shope, Jour. Exp. Med , 56, 1932, 793-S22, 65, 1936, 33-41, 43-57, 173-178.

# FAMILY III. ERRONACEAE FAM. NOV.

Viruses of the Encephalitis Group, inducing diseases mainly characterized by effects on nerve tissues.

## Key to the genera of family Erronaceae.

I. Viruses of the Typical Encephalitis Group.

Genus I. Erro, p. 1248.

II. Viruses of the Poliomyelitis Group

Genus II. Legio, p. 1257.

III. Viruses of the Rabies Group. Genus III. Formido, p. 1263.

Genus I. Erro gen. nov.

Viruses of the Typical Encephalitis Group, inducing diseases mainly characterized by injuries to cells of the brain. Vectors of some known to be ticks; dipterous insects Let also thempsuit. Generic name from Latin crop, a vegrant.

The type species is Erro scoticus spec. nos.

# Key to the species of genus Etto.

- Affecting sheep principally, but also man.
   Erro scoticus.
- II. Affecting man principally.
  - 2. Erro zilvestris
  - 3. Erro incognitus.
    - 4. Erro japonicus.
    - 5. Erro neli.
      6. Erro scelestus.
- III. Affecting horse principally, but also man.
- IV. Affecting horse, cow, sheep.
- . . . .
- 1. Erro scoticus spec. nov. From Latin Scoticus, Scottish. Common name Louping-ill virus.

Mosts - ROVIDAE-Oris artes L., sheep. HOMINIDAE-Home septems L., man. Experimentally, also mause, rat (subclinical infection), chick embryo (discrete primary lesions on chomoliantoic membrane), Macacus thesus, horse, cow, pig.

Insusceptible species: Guinea pig,

Geographical distribution: Scotland, northern England.

Induced disease Insheep, encephalitis characterized by duliness followed by incoordination of movement, frequently with tremors chiefly of the head, saliva-

S. Erro bornensis.

tion, champing of laws; pro 'ration, coma, In man, ence halitis nith death. prompt and complete re overy accompanied by formation of specific neutralizing antibodies. In mene, experimentally, diffuse encephalon , clitis with mild meningeal involvement, following intracerebral inoculation, fine rhythmical tremor involving neck, nose, and ears, unsteadiness, muscle spasms, respiratory distress, sometimes clonic and rarely tonic convulsions: hind limb paralysis, dribbling of urine, resention of spontageous limb movements, death; in mouse inoculated intraperitoneally, virus usually enters central nervous system by way of the olfactory mucosa and olfactory bulb, occasionally by trauma at points of

damage; in mouse inoculated intranssally, virus enters blood and reaches the olfactory bulb where it multiplies to a high concentration before infecting the remainder of the brain and the rest of the nervous system, tends to disappear from the blood after sickness begins but persists in the brain until death from encephalitis. In chick embryo, after inaculation of charicallantaic membrane. edems and opacity apreading from site of innculation on membrane of 10-day embryo, in 12-day eggs, discrete primary lesions, sometimes with secondary lesions surrounding them on the inoculated membrane . embrya dies in about 6 days, after showing raundice, edema, mottling of the hver with necrosis; virus regularly in blood. In monkey, Macacus thesus, progressive cerebellar ataxia: encephalomyelitia with involvement and massive destruction of Purkinge cells in the cerebellum.

Transmission: By ticks, Rhipscepholus appendisulatus and Indea recens (INO-DIDAE) in Hippscepholus appendieulatus, the larva or synsyth becomes intected, only a few individuals retain virus until the adult stage, virus does not pass through the egg. Non-tiruliferous ticks do not nequire virus by feeding with infective ticks on immune animals. Experimentally, by intracerebral or intraperional injection in mouse, by intransasi instillation in rat, mouse, and monke?

Secological relationships. Complement fivation and neutralization tests show cross, reactions with Russian spring-summer encephalitis wires, but immune serum against hoping ill sirus is only partially effective in neutralizing the spring summer encephalitis yirus.

Immunological relationships. Mice are protected against louping-ill sirus by saccination with non-strulent opting-ammer encephalitis sirus but protection is less effective than for the homologium sirus. No cross immunity with respect to Rift Valley fever virus or polomicalitis virus in Macacus rheus, but immunity with in Macacus rheus, but immunity.

with respect to reinfection by louping-ill

Thermal inactivation: At 58° C in 10 minutes.

Filterability: Passes Berkefeld V, N, and W filters.

Other properties: Viable in broth filtrates after storage at 4° C and pH 7.6 to 8.5 for 70 days. Particle diameter, calculated from ultrafiltration data, 15 to 20 millimicrons.

Literature: Alexander and Neitz, Vet. Jour., 89, 1933, 320-323; Onderstepoort Jour. Vet. Sci. and Anim. Industr., 5. 1935, 15-33; Alston and Gibson, Brit. Jour. Exp. Path., 12, 1931, 82-88; Burnet. Jour. Path, and Bact., 42, 1936, 213-225; Brit. Jour. Exp. Path., 17, 1936, 294-301; Burnet and Lush, Austral, Jour. Evo. Biol. and Med. Sci., 16, 1938, 233-240; Casals and Webster, Science, 97, 1913. 246-248; Jour. Exp. Med., 79, 1944, 45-63. Elford and Gallonay, Jour, Path. and Bact . 37, 1933, 381-302; Findlay, Brit. Jour, Exp. Path., 13, 1932, 230-236; Fite and Webster, Proc. Soc. Exp. Biol. and Med., 51, 1931, 695-698; Gallonay and Perdrau, Jour. Hyg., 55, 1935, 239-346; Hurst, Jour Comp. Path, and Therap., 44, 1931, 231-245, M'Tadvenn, Jour. Comp. Path. and Therap., 7, 1891. 207-219, 15, 1900, 145-154; Pool et al., thid . 45, 1930, 253-200, Rivers and Schnemker, Jour. Exp. Med., 59, 1934. 609-655, Schnentker et al., ibid., 67. 1933, 955-965.

2. Erro effective spec. nor. From Latin affective, of the forest, in reference to incidence of the induced disease almost exclusively in those who enter forest lands.

Common names. Spring summer encephalitis virus, forest spring encephalitis virus.

Hests Man; probably cattle, horse; Edwards anothers orienfalls, fletonys, refocance areafers. Layerementally, also white mouse, Macacus theory, hields, go white mouse, Macacus release, pieces Thom., Creetalus furunchus. Geographical distribution: Union of Soviet Socialist Republics.

Induced disease: In man, neute nonsuppurative encephalitis, abrupt onset, steep rise of temperature to 38 to 40°C, severe headache, giddiness, and vomiting; parcess and paralyses of upper of lower limbs or muscles of neck nod back; residual atrophic paralyses common; mortality among cases, 30 per cent, 80 per cent of all cases occur in May and June.

Transmission By tick, Izodes persulcatus (IXODIDAE); the virus seems to inhernate in this species and has proved capable of passing through eggs to progeny. Experimentally, also by ticks Dermacentor silvarum and Haemaphysalis concinna (IXODIDAE).

Scrological relationships: Virus-neutralizing antibodies, found without other ovidence of disease in some men and in many cattle and horses, believed to indicate susceptibility of these hosts to latent infections. No cross neutmilization with St. Louis encephalitis virus. Japanese summer encephalitis virus is in part antigenically related, but some antigenic constituents of this virus are missing in apring-summer encephalitis virus and vice versa.

Immunological relationships: Formolized virus immunizes specifically.

Filterability: Passes Berkefeld and Chamberland filter candles.

Literature Smorodintseff, Arch. 1. gesamt. Virusforsch., 1, 1940, 468-489; Soloviev, Acta Med. U. R. S. S., 1, 1938, 484-492 (Biol. Abst., 17, 1943, 1726, no. 18777).

3. Erro incognitus spec. nor. From Latin incognitus, unknown, in reference to mystery surrounding the nature and relationships of this virus, as evidenced by common name.

Common name · Australian X-disease

Hosts. HOMINIDAE—Home saprens L, man. Experimentally, also sheep, horse, cow, rhesus monkey. Geographical distribution · Australia.

Induced disease: In man, policencephalitis, especially in children, occurring in late summer; mortality high; characterized by headache, body pains, drowsiness, weakness, then vomiting, fever, convulsions; paralysis of limbs, eyemuseles, or face rare; recovery rapid in non-fatal cases.

Literature: Kneebone, Austral. Jour. Exp. Biol. and Med. Sci., 3, 1926, 119-127; Perdrau, Jour. Path. and Bact., 42, 1936, 59-65.

4. Erro japonicus spec, nov. From New Letin Japonia, Japan,

Common name: Japanese B encepha-

Hosts: HOMINIDAE—Homo sapiens L., man. Experimentally, also young sheep, mouse, and Macacus rhesus. Geographical distribution: Japan,

Union of Soviet Socialist Republics.

Induced disease: In man, loss of appetite, drowsiness, nusea, then rapid rise of temperature, pains in joints and chest; restlessness followed by apathy, coma, death, usually before end of second week, or recovery, sometimes with persistence of evidences of damage done to the nervous system by the disease.

Serological relationships. Specific antiserum does not neutralize St. Louis encephalitis viruso louping-ill virus. Itussian autumn-encephalitis virus induces the formation of antisera neutralizing Japanese B encephalitis virus. Russian spring-summer encephalitis virus contains some, but not all, antigens in common with this virus. Australian X-disease virus is distinct in neutralization tests.

Immunological relationships: Specific immunity as a result of earlier infection in mice; no cross protection with respect to St. Louis encephalitis virus. Vaccuration with Japanese B encephalitis virus does not enhance resistance to West Nile encephalitis virus but only to the homologous virus.

Thermal inactivation: At 56° C in 30 minutes

Filterability · Passes Berkefeld N, W, Chamberland La, Lt, and Seitz LK filters, with care

Laterature. Kudo et al., Jour Immunol., 32, 1937, 129-135; Smorodintseff et al., Arch. f. gesamt. Virusforsch., 1, 1940, 550-559, Webster, Jour Exp. Med., 57, 1938, 609-618

5. Erro nili spec yor. From I atm Vilus, god of the Nile Common name West Nile encer bahits

tirus Hosts HOMINIDAE-Homosapirna

I., man (perhaps without inducing any definite disease). Experimentally, also ricens number mease.

Geographical distribution Africa (Uganda)

Induced decase. In man, no details are known , virus was originally isolated from blood of a woman rative of Uganda, at the time the temperature of the patient was 100 6° 1' but she denied illness, moreover, two laboratory workers developed neutralizing antibodies without recognizable clinical disease. In mouse, experimentalls, after intracerebral incentation, incubation period to 4 or 5 days, then hyperactivity and roughening of coat; later, weakness, hunched attitude, sometimes paralysis of hand quarters, usually coma before death. In thesus monkey, externmentally, after intracerebral or intranasal inoculation, fever and enerricalities

Serological relationships Ancios reactions in complement fixation tests between the and equine encephalitis virus, Japanes el necephalitis virus, et a. Japanes el necephalitis virus. Neutralitation tests show some common antigens in West Nile encephalitis virus, Japanese B encephalitis virus, Japanese B encephalitis virus, Japanese B encephalitis virus, antiverium for West Nile virus does soit reutralitie either of the others but antivar against St. Lonis virus may neutralitie West Nile virus and a sutgest

against Japanese B virus have some effectiveness in neutralizing both West Nile virus and St. Louis virus.

Immunological relationships: Vaccination with this virus does not enhance resistance to Japanese B or St. Louis encephalsis viruses but only resistance to the homologous virus.

Thermal mactivation. At 55° C, not at 50° C, in 30 minutes.

Filterability Passes Berkefeld V, N, and W filter caudles readily; also passes Settz EK astestos pads and collection membranes 79, not 62, millimicrons in average pore diameter.

Other preperties Infective particle 21 to 31 millimicrops in diameter, as calculated from filtration experiments. Viable at least 2 weeks at 2 to 4° C. Viable after drying from the frozen state.

Laterature Havena et al., Jour. Exp. Med., 77, 1913, 130-153, Smithburn, Jour. Immunol., 44, 1912, 25-31, Smithburn et al., Am. Jour. Trop. Med., 89, 1919, 471-402.

6. Erro acelestus spie not. From

Common name St. Louis encephalitis

Hosts HOMINIDAE-Homo copiens L. man A great number of mampials and lards in endemic areas may have anticera that neutralize the virus, indicating that they are probably natural hosts, among these are ANATIDAE-Anas platurhuncha L . Mallard and Pokin ducks, Anser anser (L.), domestic grove EOVID.1E-Ros taurus L., cow, Capra hireus L, goat, this aries I, slicen. CANIDAE-Canis familiaris L, ilog COLUMBIDAE-Columbalura, domestic piccon. Zengidura macroura, nextern mourning dove. EOUIDAE-Ecuts caballus L., horer. FALCONIDAE .-Falco sparrerius I., sparrow bank LE. PORIDAE-Levus californicus Grav. tack raldet, Sylvilogue nuttolli, cortontail rabbat. MELEAGRIDAE-Meleagriz gellopaco L., turkey, MURIDAE - Estius norcegieus (Berkenlout), brown

rat. MUSCICAPIDAE—Turdus migratorius L., robin. PHASIANIDAE—
Gallus gallus (L.), chicken; Lophartyz californica, California quail. PICIDAE
— Asyndeemus levis, Lewis woodpecker; Colaptes cafer (Gm.), red-shafted flicker.
STRIGIDAE—Bubovirginionus (Gm.), great horned owl. SUIDAE—Susserofa
L., pic. Experimentally, white mouse some substrains of the Swiss white mouse are genetically more readily infected than others); Macaeux rhesus; pigeon (inapparent infection); chick embryo and to a limited extent the young hatched cluck.

Insusceptible species: Laboratory rabbit, Cabus monkey, guinea pig, rat.

Geographical distribution: United

Induced disease. In man, during aummer and fall, about 9 to 21 days after exposure, headache, high fever, rigidity of neck, tremors, encenhalitis, usually with fever; some patients become dronsy, others sleepless or delirious; usual requelae headaches, irritability, some loss of memory, and drowsiness; neutralizing antibodies maintained in vito at least 21 years after occurrence of disease. Experimentally, in susceptible strains of white mouse inoculated by intracerebral injection, after 3 to 4 days, coarse tremors, convulsions, prostration, death; perivascular accumulations of mononuclear leucocytes throughout brain, stem, cord, and pia, with destruction of pyramidal cells in the lobus piriformis and curni Ammonts, subcutaneous and intraperitoneal injections immunize against subsequent infection by intracerebral inoculation, virus reaching only blood and spleen in the process of immunization unless an excessive dose is given, some substrains of the White Swiss mouse are relatively resistant to infection, requiring inoculation with about 1000 times the minimal infective dose for highly susceptible strains and wien infected proving relatively poor sources of virus for submoculation; highly susceptible substrains of the White Swiss mouse lack a single

major, dominant, genetic factor that is present in resistant substrains.

Transmission. By meaquito, Culez tarzelis Coquillett (CULICIDAE), probably extensively; this insect has been collected in nature carrying the virus. Experimentally, by larvae of American dog tick, Dermacentor variabilis (Say) (INODIDAE); by meaquito, Culezpriptiens Lina, var. pallans Coq. (Cult. CIDAE). To mice, by feeding on infected dissues

Serological relationships: Human antisera may neutralize virus after clinical and aubelinical attacks.

Immunological relationships: Specific intracerebral immunity after vaccination by subcutaneous or intraperstoneal injection in mice appears early (about 1 need after vaccination) and disappears before lumoral antibody titer reaches its max-

Thermal inactivation: At 55° C in 30 minutes.

Filterability: Passes Berkefeld V and N filter candles and collodion membranes 66 millimiterons in average pore diameter.

Other properties: Storage in human burner itseen in ji, serine inactivates this virus in about 32 days. Diameter of infective particle enheulated from filtration data as about 20 to 35 millimicross. In storage, rabbit and abeep sera act to some extent as preservatives. At 4° C, after drying in racew while frozen, vikable in apparently undurinished inter for at least 17 months.

Literature: Barg and Reeves, Jour. Inf. Dis., 70, 1942, 273-274; Bauer et al., Proc. Soc. Exp. Biol. and Med., 31, 1934, 696-699, Blattner and Cooke, Jour. Inf. Dis., 70, 1942, 226-230; Blattner and Heys, Proc. Soc. Exp. Biol. and Med., 43, 1941, 707-710; Cook, Jour. Inf. Dis., 63, 1933, 260-246; Cook and Hudson, ibid., 61, 1937, 289-292; Elford and Perdrau, Jour. Path. and Bact., 40, 1935, 143-145; Harmson and Howitt, Am. Jour. Hyr., 55, 1942, 163-185, Harmson et al., Science, 94, 1941, 205-206, 267-272, 278-141, Dis., 70, 1942, 263-266, 267-272, 278-

283: Harford and Bronfenbrenner, Jour. Int. Dis., 70, 1942, 62-68; Harrison and Moore, Am. Jour. Path., 13, 1937, 361~ 375: Hodes, Jour. Exp. Med., 69, 1939, 533-513; Hodes and Webster, abid., 68, 1938, 263-271 : Lennette and Smith, Jour. Inf. Dis . 65, 1935, 232-251; Mitamura et al., Trans Soc. Path. Jap., 27, 1937, 573-550: Muchenfuss et al., U. S. Pub. Health Service, Public Health Rent., 48, 1933. 1311-1313, O'Leary et al., Jour. Exp. Med., 75, 1942, 233-246; Reeves et al , Proc. Soc. Exp. Biol. and Med. 60, 1942. 125-128, Sulkin et al., Jour. Inf. Dis., 67, 1910, 252-257; Webster, Jone, Exp. Med., 65, 1937, 261-286; 68, 1938, 111-121; Webater and Clow, shid., 63, 1936, 433-448, \$27-815: Webster and Tite, thid, 61. 1935, 103-114, 411-122; Webster and Johnson, 101d., 74, 1911, 489-494, Webster nt at . 61, 1935, 479-487; 62, 1935, 827-817.

7. Erro equipus spec. nor. From Latin equinue, pertaining to horses.

Common name. Equine encenhalitis

Hosts. EQUIDAL-Equus caballus L . horse : Tr hybrid of the horse and E asinus L., mule. HOMINIDAE-Homo saviens L., man, COLUMBIDAE-Calumba livia, domestic pigeon I'IIA-SIAN IDAE-ring pecked pheasant. TETRAONIDAE-Tymponuchus cupido L. var americanus (Reichenboch). prairie chicken Many additional speeies have been found to show neutralizing antisers at times and these are presumably natural hosts of the virus upon occasion, among them are: ANATIDAE-Anas platyrhyncha L., Mallard and l'elin ducks, Anser anser (L.), domestic coore BOVIDAE-Bostaurus L. cow. Carra hireus I., gort , Oris aries L., sheep. CANIDAE-Conts Jamiltoris L., doc. CHARADRIIDAE-Osycchus rociferus 1. Addeer CRICETIDAE-Microtus montanus (Peale), field moure, Peromyscus maniculatus (Wagner), white footed mouse FALCONIDAE-Falco sparretrus L. sporrow hawk. MELEAGRI-DAE-Meleagris galloparo L., turkes.

MITRIDAE-Rattus rattus L., black MUSCICAPIDAE-Turdus mimaterius L., robin, MUSTELIDAE-Mustela frenata Lichtenstein, weasel. PHASIANIDAE-Gallus callus (L.). chicken: Lophortuz californica, California quail: Phasianvs colchicus L., ringnecked pheasant. PICIDAE-Colopies enter (Cm.), red-shafted flicker. STRI-GIDAE-Buba virginianus (Gm.), great horned owl. SUIDAE-Sus scrofa L., me. Experimentally, also chick embryo. coose embryo, pheasant embryo, robin embryo, piecon embryo, turkey embryo, sparrow embryo, duck embryo, and guinea-fowl embryo; white mouse, guinea nie, rabbit, pigeon, white rat, calf, sheen, monkey, goat, dog, ben, turkey; Zonotrichia leucophrus cambeli. Gambel sparrow: Passer domesticus L., English sparrow: Lophortyz californica, quail: Juneo orcoanus, junco: Tozastoma leconter lecontei, thrasher : Citellus richardsonii (Sabine), gopher or Richardson's ground souirrel; Stomodon hispidus Say and Ord. cotton rat; Dipodomys heermanni Le Conte. kancaroo rat: Rethrodontomun megalatus, wild mouse: Microtus montonus, M colifornieus and M. mordaz. wild mice . Peromyseus maniculatus (Wag. ner), white footed mouse; Neotoma fuseipes Baird, wood rat: Sulvilaous bachmoni (Waterbouse), brush rabbit; S. audubents (Baird), cottontail rabbit: Canis familiaris L , dog (pupples); Anser cinereus, goose: Anas boscas L., duck: Circus rulus (Gm.), bank: Turdus merula L., blackbird, Ciconia ciconia L., white stork, Pultur fuleus Bries., tawny vulture; Marmola monax (1.), woodchuck, Microtus pennsulconiena (Onl.). feld vole; Speolyto cunicularia hupunaca (Bonaparte), western burrowing only Molothrus oter (Boddaert), combied; common qual or bob white. Insusceptible species: Frog (cat and

opossum reported as "refractors").

Geographical distribution; United States, Canada, Argentina.

Induced dream: In horse, initial fever. then signs of latigue, compolence; occa-

sional excitability followed by incoordinated action of limbs, disturbed equilibrium, grinding of teeth, paresis and varied paralyses; frequently inability to swallow, paralysis of lips and bladder, amaurosis; case fatality about 50 per cent; recovery without sequelae in mild cases; death within 3 to 8 days in severe cases. In man (children particularly vulnerable), a profound, acute, disseminate and focal encephalomychtis characterized by intense vascular engorgement, perivascular and parenchymatous cellular infiltration and extreme decenerative changes in the nerve cells. In chick embryo, excessive increase of virus continuing until just before host's death, virus being found eventually throughout the egg but most concentrated in the embryo; vaccines made from virus grown in chick embryo and then inactivated are especially effective because of the high titer of virus represented in them; increased resistance with age characteristic of choricaliantoic membrane as well as of batched chick: rounded acidophilic masses occur usually near periphery of nucleus in embryonic nerve cells; no such inclusions are found as a result of infection with Borna disease virus or poliomyelitis virus.

Transmission . Experimentally by tick, Dermacentor anderson: Stiles (IXODI-DAE), passing through eggs to offspring: this tick is infective to susceptible animals on which it feeds as larva, nymph or adult. Experimentally by Aedes acgypti L. (to guinea pig and horse, preinfective period 4 to 5 days; insects retain virus for duration of life, not to eggs of infected mosquitoes; not passed from males to females or by males from female to female), A. albopictus, A. atropalpus, A. cantator, A. dorsalis, A. nigromaculis, A. sollicitans, A. taentorhynchus, A. triseriatus, and A. rezons (CULICIDAE). Triatoma sanguisuga (Le Conte) INE-DUVIIDAE) has been found infected in nature and has transmitted virus experimentally to guinea pigs. The American dog tick, Dermacentor variabilis Say (IXODIDAE) has been infected by

inoculation, not by feeding; it has not been shown to transmit.

Serological relationships: Neutralizing antibodies are formed as a result of vaccination with inactive, formolized virus; antigenicity of formalin-inactivated virus as well as of active virus is blocked in the presence of antiserum. In rabbit, cerebral resistance is coincident with presence of neutralizing antibody in spinal fluid. In guinea pig, therapy with specific antiserum ineffective if begun after onset of encephalitis; effective if begun within 2t to 48 hours of peripheral inoculation. No cross neutralization reaction with lymphocytic choriomeningitis virus. Japanese B encephalitis virus or St. Louis encephalitis virus. Constituent strains (typical Western and Eastern) do not give cross neutralization reactions, but do show the presence of common antigens by cross reactions in complement fixation not shared with such other viruses as Japanese B encephalitis virus, St. Louis encephalitis virus, West Nile encephalitis virus, lymphocytic chariomeningitis virus. Sera of human eases may be negative by complement fixation tests a few days after onset, yet strongly strain-

specific chring second week of illness.
Immunological relationships: Young of
immunized guinea pigs are immune to
homologous strain at least a month after
birtli. No cross immunity between
Western and Eastern strains of equine
concephalitis virus.

Thermal inactivation · At 60° C, not at 56° C, in 10 minutes.

Filterability: Passes collodion membranes 66, not 60, millimierons in average pore diameter. Passes Berkefeld V, N,

and W, finest Mandler, and Seitz filters.
Other properties: Inactivated below pH 5.5. Viable at least a year, dry in vacuum. Particle diameter estimated from filtration experiments to be 20 to 30 millimicrons. Electron micrographs show particles as spherical or disk-shaped, about 39 millimicrons in dumeter with round or oval region of high density within each, older preparations show

Attack phenol and cresol at times, also paphthalenc.

Acrobic, facultative.

Optimum temperature 25°C. Habitat: Manure and soil.

45. Pseudomonas dacunhae Gray and Thornton, (Grav and Thornton, Cent. f. Bakt., II Abt , 73, 1928, 90; Achromobacter daeunhae Bergey et al . Manual, 3rd ed., 1930, 217.) From M L from the Island of d'Acunha.

Rods: 0.5 to 0.8 by 1.5 to 3.0 microns. Motile with one to six polar flagella

Gram-negative.

Gelatin colonies: Circular, whitish, raised, smooth, glistening, undulate Gelatin stab: No liquefaction.

Agar colonies: Circular to amoeboid, white, flat, glistening, opaque, entire Agar slant: Filiform, pale bull, raised,

smooth, glistening, undulate

Broth: Turbld.

Nitrites produced from nitrates.

Starch not hydrolyzed. No acid from earbohydrate media Attack phenol.

Aerobie, facultative.

Optimum temperature 25°C. Habitat : Soil.

46. Pseudomonas arvilla Gray and Thornton, (Gray and Thornton, Cent f. Bakt., II Abt., 73, 1928, 90; Achromobacter arvillum Bergey et al , Manual, an arable field; M. L. dim. a little field.

3rd ed., 1930, 217 ) From Latin, arvum, Rods: 0.5 to 0.7 by 2.0 to 30 microns. Motile with one to five polar flagella.

Gram-negative.

Gelatin colonies: Circular, whitish, convex, smooth, glistening, lobste

Gelatin stab: No liquefaction Agar colonies. Circular or amoeboid, white to buff, flat to convey, smooth,

glistening, opaque, entire. . Agar slant : Fililorm, whitish, concave,

smooth, ringed, entire. Broth : Turbid.

Nitrites not produced from nitrates.

Starch not hydrolyzed. Acid from clucose. Attacks naphthalene. Aerobic, facultative. Ontimum temperature 25°C. Habitat . Soil

47. Pseudomonas salonium Grav and Thornton, (Gray and Thornton, Cent. f. Bakt., II Abt., 73, 1928, 91; Achromobacter salopium Bergey et al., Manual. 3rd ed , 1930, 219 ) From Latin, Salop, Shronshire.

Rods: 0.7 to 1.0 by 1.0 to 3.0 microns. occurring singly and in pairs. Motile with one to six polar flagella negative.

Gelatin colonies: Circular, gravishbuff, flat, rugose or ringed, translucent border

Gelatin stab. No liquelection

Agar colonies: Circular or amosboid. white to buff, flat to convex, smooth, glistening, translucent border, entire. Agar slant: Filiform, whitish, raised,

smooth, glistening, lobate. Broth: Turbid with pellicle.

Nitrites not produced from nitrates. Starch not hydrolyzed.

Acid from glucose and sucrose Attacks naphthalene.

Acrobic, facultative. Optimum temperature 25°C.

Habitat: Soil.

48. Pseudomonas minuscula McBeth. (McBeth, Soil Science, 1, 1916, 437; Cellulomonas minuscula Bergey et al., Munual, 1st ed., 1023, 162.) From Latin dim. rather small.

Rods: 0.5 by 09 micron. Motile with one to two polar flagella. Gram-negative. Gelatin stah: Moderate growth. Slight napilorm liquelaction.

Agar colonies: Small, circular, slightly convex, butyrous becoming brittle, grayish-white, finely granular, entire.

Agar slant: Moderate, flat, grayishwhite.

Broth : Turbid.

824; Jour. Bact., 53, 1937, 60; Am. Jour. Hyg., 52 (B), 1940, 19-23; 53 (B), 1941, 37-41; Jour. Exp. Med., 73, 1941, 507-529; Taylor et al., Jour. Inf. Dis., 67, 1940, 59-66; 69, 1941, 224-231; 72, 1943, 31-41; TenBroeck, Arch. Path., 25, 1938, 759 (Abst.); TenBroeck and Merrill, Proc. Soc. Exp. Biol. and Med., \$1, 1933, 217-220; TenBrocck et al., Jour. Exp. Med., 62, 1935, 677-685; Traub and Ten Brocck, Science, 81, 1935, 572; Tyzzer and Schlards, Am. Jour. Hyg., 53 (B), 1941, 69-81; Tyzzer et al., Science, 88, 1938, 505-506; van Rockel and Clarke, Jour. Am. Vet. Med. Assoc., 94 (N.S. 47), 1939, 466-468; Webster and Wright, Selence, 88, 1933, 305-306; Wesselhoeft et al., Jour. Am. Med. Assoc., 111, 1938, 1735-1740; Wright, Am. Jour. Hyg., 36, 1912, 57-67.

8. Erro bornensls spec. nov. From Borna, name of a town in Saxony where a severe epizoctic occurred in 1894 to T896.

Common name: Borna-disease virus.

younger), mouse; Macaca mulatta (Limmermann) rhesus monkey.

Insusceptible species: Ferret, cat,

pigcon; probably dog.

Geographical distribution. Wurtemburg, Germany, North and South America, Hungary, Russia, Belgium, France, Italy, Roumania.

Induced disease: In horse, encephalomyelitis characterized by lassitude, indifference to external stimuli; later intermittent excitement, difficulty in mastication and deglutition, spasms in various muscles, champing, excessive salivation; pupils unequal in size; paralysis of hindquarters, tail, muscles of tongue, or muscles of back; temperature usually normal; death in 20 to 37 hours or, less often, recovery after about 1 to 3 weeks. Virus may pass placenta and infeet fetus in pregnant anımals.

Transmission: To rabbit, experimentally by feeding and by injection intracerebrally, intraocularly, nasally, intravenously, subcutaneously, or intraperitoncally; not by living in same cage,

Immunological relationships: No cross immunity conferred by the Western straia of equinc encephalomyelitis virus. Isolate of Borna disease virus from the horse immunizes rabbits against isolate from sheep, and tice versa. Herpes and rabies viruses do not immunize rabbits against subsequent infection by Borna disease virus.

Thermal inactivation: At 50 to 57° C in 30 minutes; at 70° C in 10 minutes.

Filterability: Passes Berkefeld N and Mandler filters, but with difficulty. Passes collodion membranes of average pore diameter 400 millimierons readily, 200 millimierons with difficulty, 175 millimicrons not detectibly. May be separated by differential filtration from louping-ill virus, which will pass even a 125-millimicron membrane.

Other properties: Particle size estimated from filtration data as 85 to 125 millimicrons. Optimum pH for stability in broth at 15 to 20° C is 7.4 to 7.6; very sensitive to greater alkalinity Viable after 327 days dry at laboratory temperatures. Viable at least 6 months in 50 per cent glycerine. Inactivated by putrefaction in 5 days; by 1 per cent carbolic acid in 4, not in 2, weeks.

Literature: Barnard, Brit. Jour. Exp. Path., 14, 1933, 205-206; Covell, Proc. Soc. Exp. Biol. and Med., 52, 1934, 51-53; Elford and Galloway, Brit. Jour. Exp. Path., 14, 1933, 196-205; Howitt and Meyer, Jour. Infect. Dis., 54, 1934, 364-367; Nicolau and Galloway, Brit. Jour. Exp. Path., 8, 1927, 336-341, and in Medical Research Council, Special Report Series No. 121, London, 1928, 90 pp., Ann. Inst. Pasteur, 44, 1930, 673-696; 45, 1930, 457-523, Zwick et al., Ztschr. Infektionskr. parasit. Kranklı, u. Hyg. d. Haustiere, 30, 1926, 42-136; 32, 1927, 150-179.

comma-shaped particles. Sedimentation constant, mean 26.5. × 10<sup>-14</sup> ± 5.4 × 10<sup>-14</sup> (range 252 to 276 × 10<sup>-14</sup>). Specific volume 0.861. Molecular weight of tiponucleoproten complex behaving as the virus enteulated as 135 million, approximately 250 particles gwing 50 per cent infection, material contains 4 per cent carbohydrate. Absorption of ultraviolet light reaches a peak at about 2000 Å, a broad minimum at about 2450 Å, and an siccrase at 2700 Å.

Strains The Western strain (so-called Western counc encephalitis virus) may be considered as type of a large group of variants met in nature, some produce clinically milder disease than others (Birch, Am Jour Vet Res , 2, 1941, 221-226), they may change in virulence on passage in experimental hosts. The l'astern strain (so-called Lastern couine encephalitis virus) has been studied extensively also, and has been found to differ from the type strain especially un more rapid course of induced disease in the horse, in being experimentally transmusible to sheep, pig. dog, cat and the European hedgebog; in its localization in outern coast states and alcence from the area between California and Wisconsin. where the type strain is found, in failure experimentally to infect Aides acquite unless morniated into body cavity by needle puncture, whereupon it persists and can be transmitted, and in failure of erost neutralization with the western strain A strain produced by serial passage in pigeons is reported to have caused no obvious reaction in horses but to have induced the formation of neutralizing antibodies A Venezuelan strain differs from the type in comple ment fixation reactions, it induces in man a mild disease, characterized by malaise, fever, headache or drowsmess, and uneventful recovery (Casaly et al., Jour. Exp. Med., 77, 1943, 521-530)

Laterature Bang, Jour, Lxp Med., 77, 1913, 337-314, Bauer et al., Proc Soc. Exp Biol and Med., 55, 1935, 378-382, Peartlet al., Science, 87, 1935, 490, Barch.

Am. Jour. Vet. Res , 2, 1941, 221-226; Casals and Palacios, Science, 94, 1941, 330. Covell. Proc. Soc. Evp. Biol. and Med , \$2, 1934, 51-53; Cox, 1bid., \$5, 1936. 607-609; Cox and Olitsky, Jour. Exp. Med . 65, 1936, 745-765 . 64, 1936, 217-222, 223-232, Cox et al., U S. Pub. Health Service, Public Health Rent , 56, 1941. 1905-1906; Davis, Am. Jour Hyg. 82 (C), 1949, 45-59; Eklund and Blumstein. Jour Am. Med. Assoc., 111, 1938, 1734-1735 : Feemster, Am. Jour, Public Health, 28, 1938, 1403-1410; Finkelstein et al . Jour. Inf Dis., 68, 1940, 117-126, Fothergill and Dingle, Science, 88, 1938, 549-550; Fothergill et al , New England Jour. Med., 219, 1938, 411, Cultner and Shahan, Science, 78, 1933, 63-61, Jour, Am Vet. Med. Assoc , 88, (N.S. 41), 1936, 363-374; Graham and Levine, Am. Jour Vet. Res .. 2, 1941, 430-435; Grundmann et al., Jour. Inf. Dis. 72, 1943, 163-171; Havens et al., Jour, Exp. Med., 77, 1943, 139-153, Higbio and Hangtt, Jour Bact., 29, 1935, 399-106, Howatt, Jour, Inf. Dis., 55, 1934, 139-149, 61, 1037, 88-05, 67, 1940, 177-187; Seignee, 68, 1939, 455-456; Howitt and Van Herick, Jour. Inf Dis. 71, 1942. 179-191, Kelser, Jour. Am Vet. Med. Assoc , 82, 1933, 767-771 , King Jour. Exp. Med , 71, 1949, 107-112, 76, 1942, 325-334; Kateelman and Grandmann, Kansas Agr. Exp. Sta , Tech. Bull 50, 1910, 1-15; Merrill and TenBroeck, Jour Exp. Med , 62, 1935, 687-695, Meyer et al., Science, 74, 1931, 227-228, Mitchell et al., Canadian Jour Comp Med , 3, 1939, 308-309, Mongan, Jour Lyp Med , 74, 1941, 115-132, Morgan et al , roid , 70, 1912, 357-369, Olitaky et al., ibid., 77, 1913, 359-374, Remlinger and Bailly, Compt. rend. Sec Rud , Paris, 121, 1936, 146-149, 122. 1936, 518-519, 125, 1936, 562-563; Sabin and Olusky, Proc. See Exp. Biol. and Med., 53, 1938, 507-509, Sellards et al., Am. Jour Hyg. 55 (B), 1911, 63-68; Staten and Lichborn, Am. Jour. Vet. Res , 2, 1941, 214-220, Sharp et al., Proc. For Exp. Biol. and Med , 51, 1912, 200-207; Arch. Puth , 36, 1913, 167-176; Experton and Berry, ibid., 34, 1936, 522African monkey, by intracerebral, intranasal, and intraabdominal inoculation.

Serological relationships: Specific neutralizing antibodies arise after experimental infection in monkeys, but reinfection is not prevented; only a minority of human convalencent sera neutralize virus in ruiro, the most potent sera probably being obtained from those with transient or light paralysis. Cross neutralization between monkey passage and murine (cotton-rat and mouse) strains. No cross neutralization reaction with lymphocytic choriomeningitis virus. Isolates differ somewhat antigenically, homologous titers being higher than heterologous titers in some neutralization tests.

Thermal mactivation At or below 75° C in 30 minutes.

Filterability · Passes membrane about 35, not 30, millimicrous in average pore diameter.

Other properties. Infectivity of virus maintained well at -76° C or in glycerine but poorly when dried or just frozen. Inactivated readily P2. hydrogen peroxide. Particle diameter estimated as about 12 millimerons by filtration studies. Precipitated by half-saturated ammonium sulphate solutions. Electron micrographs show elliptical particles 20 to 30 millimierons in diameter; impure infectious materials show long threads 20 by 75 to 500 millimierous in size. Component probably virus has sedimentation constant Sm. = 62 × 10-12 cm per sec. per dyne. Inactivated by potassium hydroxide, copper sulfate and potassium permanganate. Stable from pH 2.2 to 10.4 for 2 hours at 37° C

Literature Armstrong and Harrison, U. S. Pub. Health Service, Public Health Rept., 56, 1935, 725-730, Ayeock, Am. Jour. Hyg., 7, 1927, 791-803, Burnet and Jackson, Austral. Jour. Exp. Bod. and Med. Sci., 17, 1939, 261-270, 18, 1910, 361-366, Burnet et al., ibid., 17, 1939, 253-260, 375-391; Elford et al., Jour. Path, and Bact., 40, 1935, 135-141; Flex-

ner, Jour. Exp. Med., 62, 1935, 787-804; 63, 1936, 209-226; 65, 1937, 497-513; Gard. ibid., 71, 1910, 779-785; Gordon and Lennette, Jour. Inf. Dis., 64, 1939, 97-104; Harmon, ibid., 58, 1936, 331-336; Heaslin. Austral, Jour. Exp. Biol. and Med. Sci., 16, 1938, 285-286; Howitt, Jour. Inf. Dis., 51, 1932, 565-573; 53, 1933, 145-156; Hudson and Lennette, Am. Jour. Hyg., 17, 1933, 581-586; Jungeblut and Bourdillon, Jour. Am. Med. Assoc., 123, 1943, 399-402; Jungeblut and Sanders, Jour. Exp. Med., 72, 1940, 407-436; 76, 1942, 127-142. Jungeblut et al., ibid., 75, 1942, 611-629; 76. 1942, 31-51; Kessel et al., Am. Jour. Hyg., 27, 1938, 519-529; Jour, Exp. Med., 74, 1941, 601-609; Kolmer et al., Jour, Inf. Dis., 61, 1937, 63-68; Kramer et al., Jour. Exp. Med., 69, 1939, 46-67; Lennette and Hudson, Jour. Inf. Dis., 58, 1936, 10-14; Loring and Schwerdt, Jour. Exp. Med., 75, 1912, 395-496, McClure and Langmuir, Am. Jour. Hyg , \$5, 1942, 285-291; Melnick, Jour. Exp. Med., 77, 1943, 195-204; Moore and Kessel, Am. Jour. Hyg , \$8, 1943, 323-314; Moore et al., ibid., 56, 1912, 247-254; Morales, Jour. Inf. Dis, 46, 1930, 31-35; Olitsky and Cox, Jour. Exp. Med., 63, 1936, 100-125; Paul et al., Am. Jour. Hyg., 17, 1933, 587-600; 601-612; Jaur. Exp. Med., 71, 1940, 765-777; Sabin, 16id., 69, 1939, 507-516; Sabin and Olitsky, thid., 68, 1933, 39-61; Sabin and Ward, abid., 75, 1941, 771-793; 74, 1942, 519-529; 75, 1942, 107-117, Sabin et al., Jour Bact., 31, 1936, 35-36 (Abst.); Sanders and Jungeblut, Jour. Exp. Med., 75, 1942, 631-649; Schultz and Gebhardt, Jour Inf. Dis., 70, 1942, 7-50; Schultz and Robinson, sbid., 70, 1942, 193-200; Stimpert and Kessel, Am. Jour. Hyg, 29, (B), 1939, 57-66; Theiler, Medicine, 20, 1941, 443-462; Theiler and Bauer, Jour. Exp. Med., 60, 1934, 767-772; Trask and Paul, ibid., 58, 1933, 531-544; 75, 1941, 453-459; Trask et al., tbid., 77, 1943, 531-511: Turner and Young, Am. Jour. Hyg., 37, 1943, 67-79; Wolf, Jour. Exp. Med., 76, 1942, 53-72; Young and Merrell, Am. Jour Hyg., 37, 1943, 80-92.

#### Genus II. Legio cen vo-

Viruses of the Poliners' probably because of a ... also obvious invalve.

nervous exstem Generic name from

the nervous

Latin legio, an army & argion.

The type species is Legio debilitans spec nov.

### Ken to the species of genus Legio.

- I. Affecting man (see also IV below)
- 1. Legro debilitans.
- Legio crebea.
   Legio simulans.
- II. Latent in, or affecting, mouse
- 4. Legio muris.

HI. Affecting birds.

- e. Degit maris,
- IV. Affecting swine and swineherds.
- 5 Legio gallinae
- 1. Legio debilitans spec. nov From Latin debilitare, to weaken or maim

6 Legio suariorum.

Latin debilitare, to weaken or maim Common names Poliomyelitis virus, virus of infantile pamlysis.

Hosts. HOM! NIDAE—Home supress.
L. man Experimentally, Cercoputheeus acthops sebaeus, green African monkey; Macaca mordear, M. mulaita, the rhesus monkey; M. trus, the eynomolgus monkey mona monkey; for some solates, Sigmodon hivpidus Eny and Ord, cotton rat; mouse, guincap gg; white rat

Insusceptible species: Sheep ("refinetory" but forms neutralizing antibodies), chicken.

Geographical distribution: Almost

Induced disease. In man, probably subclinical in most cases, in view of the presence of specific antifudies in semfrom the great majority of adults in all parts of the northy virus probably infects some part of the alimentary tract, being dound in stools of mest clinical cases, of most apperently lealthy contacts, and even of some individuals who lake recovered from attorities attack in one case 123 days after attack); clinical disease, largely in children, is characterized by invasion of central nervous system, multieffects marging from sore threat, fever. vomiting, and beadache to sudden and severe paralysis; the muscles most often involved are those of the less, but there may be paralysis of abdominal or intercostal muscles. Virus not in urine or saliva, rarely to naral washings, more often in stools of young than of old patients: an walls of pharynx, sleum, descending colon Virus has been recovered from senage Incidence and fatality affected by racial characteristics, the first lower and the second higher in negroes than in whites in the United States. In monkey, sumiar disease, no virus in blood, reinose with responsement of virus reported; in isolated intestinal loops, infection does not occur through normal mucoes in absence of antestinal contents, disease more severe to summer than in autumn. in autumn than in winter, more severe in older than in younger monkeys; no immunity follows inoculation unless obvious disease occurs.

Transmission Transmission in milk has been suspected and at times confirmed. Virus has been recovered from mixed ramples of flies in an epidemic area. No definite arthropod vector has been incriminated. Experimentally, in Cercopitheeus arthrops todous, the green

guinea pig tiesues immunize the guinea pig but vaccines made from mouse tissues do not. Mice immune to this virus are ausceptible to infection with pseudolymphocytic choriomeningitis virus and vice versa.

Thermal inactivation: At 55 to 56° C in 20 minutes.

Filterability: Passes Berkefeld V, N, and W filters and, with difficulty, a Seitz asbestos pad.

Other properties: Infective at least 206 days in storage at 4 to 10° C in 50 per cent neutral glycerine in 0.85 per cent salice. Infective particle calculated to be 37 to 55 millimicrons in diameter on the basis of centrifugation studies; 40 to 60 millimicrons by ultrafiltration tests. Inactivated by soap with loss of mouse-immunizing capacity.

Literature Armstrong and Dickens, U. S, Pub. Health Service, Public Health Rept., 80, 1935, 831-842; Armstrong and Lillie, ibid , 49, 1934, 1019-1027; Armstrong and Wooley, 161d., 60, 1935, 537-541; Jour. Am. Med. Assoc., 103, 1937, 410-412; Baird and Rivers, Am. Jour. Pub Health, 28, 1938, 47-53; Casals-Ariet and Webster, Jour. Exp. Med., 71, 1940, 147-154; Dalldorf, 201d, 70, 1939, 19-27; Dalldorf and Douglass, Proc. Soc. Exp. Biol. and Med , 59, 1938, 294-297; Findlay and Stern, Jour Path, and Bact., 43, 1936, 327-338, Findlay et al , Lancet, 230, 1936 (I), 650-654, Howard, Jour. Inf. Dis., 64, 1939, 66-77, Laigret and Durand, Compt. rend. Acad. Sci., 203, 1936, 282-284; Lépine and Sautter, Ann. Inst. Pasteur, 61, 1938, 519-526; Lépine et al., 1bid., 204, 1937, 1846-1848, Mac-Callum and Findlay, Brit. Jour. Exp. Path , 21, 1940, 110-116; Milzer, Jour. Inf. Dis., 70, 1942, 152-172, Rivers and Scott, Jour. Exp. Med., 65, 1936, 415-432; Scott and Elford, Brit. Jour. Exp. Path., 20, 1939, 182-188; Scott and Rivers, Jour. Exp. Med., 65, 1936, 397-414; Shaugnessy and Ziehis, 1bid., 72, 1940, 331-343; Smadel and Wall, abid , 72, 1940, 389-405; 75, 1942, 581-591; Smadel et al., Proc. Soc. Exp. Biol. and Med., 40, 1939, 71-73;

Jour. Exp. Med., 70, 1939, 53-66; 71, 1930, 43-53; Block and Francis, viid, 77, 1943, 322-336; Traub, Science, 81, 1935, 293-299; Jour. Exp. Med., 82, 1935, 533-546, 847-861; 64, 1936, 183-290; 86, 1937, 317-324; 68, 1938, 95-110, 229-250; 69, 1939, 801-817.

3. Legio simulans spec. nov. From Latin simulare, to imitate, in reference to resemblance of this virus to the preceding in many respects, though not in size or antigenic properties.

Common name: Pseudo-lymphocytic choriomeningitis virus.

Hosts: HOMINIDAE—Homo sapiers L., man. Experimentally, also mouse, guinea pig, rhesus monkey; choricallantoic membrane of chick embryo.

Induced disease In man, benign aseptic lymphocytic meningitis with view in cerebro-spinal fluid; severe frontal headache, drowsness, irritability, voniting, eventual complete recovery. In mouse, experimentally, roughened fur, spontaneous tremor, hunched attitude, pritability, clonic movements ending with tonic convulsions on stimulation, temporary recovery from spasm with surroyal a few hours or instant death.

Serological relationships: Hyperimmune sera for lymphocytic choriomeniagitic virus are ineffective for this virus, and vice versa. In man, after recovery, neutralizingantibody is strongat I month, fading before 7 months.

Immunological relationships: Mice acquire specific resistance to reinfection after experimental discose; mice immune to lymphocytic choriomeningits virus are susceptible to pseudo-lymphocytic choriomeningitis virus and vice versa.

Thermal inactivation: At 56° C, not at 45° C, in 30 minutes.

Filterability: Passes Berkefeld V, not N, filter candle, Gradacol membrane of 320, not 300, millimieron average poro diameter.

Other properties: Particle diameter calculated to be not above 150 to 225 millimicrons, from filtration experiments. 2. Leglo erebea spec. nor. From Latin cheus, belonging to the Lower World.
Common names 'Choriomeningitis virus, lymphocytic choriomeningitis virus. Blosts: MURIDAE—Mus musculus L., vy or white mouse. HOMINIDAE—Comosapiens I., man. CERCOPTHECI-AII—Macaca mulalla, phesus monkey hyperimentally, also gunea pig, white it; dog (masked), ferret (masked), forcac irus, orab-eating macaque, Syrin hamster; chick- or mouse-embryo erum-Tyrode solution culture, clack

Insusceptible species Pig, rabbit, ield tole, bank tole, canary, hen, paracet.

Geographical distribution Pronce,

mbrio.

England, United States. Induced disease. In white mouse, more cirulent in councithan in old individuals. infection may take place in uters or soon ifter birth, some mice become earriers after recovery, with virus in organs. blood, urine, and meal accretions, carriers are immune to large intracercural inoculations of virus, experimentally, 5 to 12 days after intracercheal inoculation of susceptible mice, somnotence, photophobia, tremors of the less, tonic spasms of muscles in the hindquarters upon stimulation, recovery or death. In man. disease may be subclinical at times as shown by the fact that some supposedly normal sera contain specific antibodies, not all clinical eases develop protecting antibodies against testing strains, so that disease may be somewhat commoner than can be ascertained readily, in all cases benign, but in the more severe of these an acute aseptie meningitis, after meubstion period of 11 to 3 days, spells of fever extending as king as 3 weeks, late in the disease there may be a meningeal reaction both chaically and cytologically , lymphoextes and some large monomiclear cells appear in the meningral fluids, although symptoms remain benign, there may be virus in the blood from the beginning

of fever to the end of the second week, the

spinal fluid is not infective at first but may become so before there is a change in cell count, urine and saliva remain uninfectious.

Transmission: In white mouse, by contact with mice unfected when young, not with those infected when old; massi mucosa considered portal of entry. In widgray mouse of the same species, Mus muscufus, by contact but less readily than in whate mouse. Experimentally, by mosquita, Addas acquyit 1. (CULICI. DAE), at 26 to 34° C, by heibug, Cimer lettellarus (CIMIDAE), but defectation on site of butten area is essential, bite alone being ineffective. Experimentally, to guinca pig, by application of virus to normal and apparently infact skin; not by contamination of food of litter.

Serological relationships. Scrum of recovered subjects usually neutralizes choriomeningstis virus. Hyperimmune serum is ineffective against pseudo-lymphoeytic choriomeningitis virus and byperimmune serum for that virus is inclfeeture in its turn when used with chonomeningitis virus No cross neutralization with St. Louis encephalities virus A specific soluble antiren assoenated quantitatively with virus in all hosts fixes complement in the presence of immune scrum, virus does so poorly if at all, the anti-soluble substance antibodies seem to be independent of virusneutralizing antibodies. A soluble protem, readily commission from virus, gives a specific precipitin reaction with immune serum, antibadies concerned are probably not the virus neutralizing antibodies.

Immunological relationships—Intraperational injection of alout 160 intracerebral lethal does hot been found to protect the white mour aguinst infection by sub-sequent intracerebral injection of 10,000 fethal does. The immune mousdiffers from the immune guines pig in showing no neutralizing antibodies in its blood, even the purses pig may develop resistance before antibodies appear in its serum. Formalized vaccines made from Cent. f. Ba'tt., I Abt., Orig., 142, 1933, 144-148; Iguchi, Kitasato Arch. Exp. Med., 16, 1939, 56-76; Olitaky, Journ. Exp. Med., 72, 1949, 113-127; Theiler, Science, 80, 1934, 122; Jour. Exp. Med., 5, 1937, 705-719; Theiler and Gard, 4bid., 72, 1940, 49-67, 79-90; Young and Cumberland, Am. Jour. Hyg., 57, 1943, 216-224

 Legio gallinae spec. nov. From Latin gallina, hen.

Common names: Avian encephalomyelitis virus, infectious avian encephalomyelitis virus.

Host: PHASIANIDAE—Gallus gallus (L.), chicken (embryo not susceptible; in culture media, minced whole embryo in serum-Tyrode solution suffices to maintain virus, but embryo brain alone does not).

Insusceptible species: All tested species other than birds.

Geographical distribution: United States.

Induced disease: In chicken, fine or coarse tremors of whole body or only of head and neck or of legs; progressive ataxia, eyes dull, some loss of weight. weakness of legs, and progressive meoordination of leg muscles; somnolence precedes death, about 75 per cent die within 5 days of onset, 90 per cent within a week, the remainder showing a staggering, ataxic gast for weeks, some continuously tremulous; recovered birds. however, may produce eggs well, nucroscopic focal collections of glia cells, perivascular infiltration, degeneration of Purkinje's cells and degeneration of nerve cells; foct of infiltration throughout brain and spinal cord, virus not detected in the blood of affected chickens.

Transmission. Not through egg. Experimentally, by intracerebral injection. Serological relationships Specific anti-

Serological relationships openin about the Eastern strain of equine encephalitis virus, autiserum specific for the latter does not neutralize avian encephalomychitis virus.

Filterability. Passes Berkefeld V and N as well as Seitz 1 and 2 filters; also membranes 73 millimicrons in average pore diameter.

Other properties: Survives in 50 per cent glycerine for at least 88 days and frozen for at least 68 days. Infective particle estimated to be 20 to 30 millimicrons in diameter, by filtration studies

Literature: Jones, Science, 75, 1932, 331–332; Jour. Exp. Med., 59, 1934, 781-798; Kligler and Olitsky, Proc. Soc. Exp Biol. and Med., 45, 1940, 680–683; Olitsky, Jour. Exp. Med., 70, 1939, 565–582; Olitsky, Jour. Exp. Med., 70, 1939, 565–582; Olitsky and Buer, Proc. Soc. Exp. Biol. and Med., 42, 1939, 634–636; Van Roekeletal, Jour. Am. Vet. Med. Assoc., 95 (N.S. 49), 1933, 372–375.

6. Legio sustiorum spec, nov. From Latin suarius, swineherd.

Common name: Swineherds'-disease virus,

Hosts: SUIDAE—Sus scrofa L., swine. HOMINIDAE—Home septem L., man. Experimentally, with fever as only symptom, white rat, eat, ferret, mouse; perhaps Macoca mulatis (2mmermann), rhesus monkey.

Geographical distribution: Europe.

Induced disease In man, n benigs meningitis without sequelas, somewhat similar to lymphocytic choriomeningitis in man; cell counts in spinal fluids may be as high as 1200 to 1400; 4 to 7 (average 8) days after infection, fever lasting 3 to 21 days (average 9); sometimes conjunctivitis, more often a reddish maculopapillose eruption; severe sweating frequent; hemorrhagic tendency; blood in feces; recovery. Blood, urine, feces infectious, not spinal fluid or mucous excretions. Especially affecting young men, not often old men or women, among those having contact with swine or swineproducing quarters.

Transmission: Excreta of pigs, even as used for manure, are infective. Experimentally, to man, by subdermal or intramuscular injection.

Viable at least 1 month at 4° C, at least 1 year in 50 per cent glycerine. 40 days in 025 per cent phenol, 1 year when dired from frozen material. Inactivated by 0 05 per cent formain at 4° C in 48 hours; hy bother in 5 minutes.

Laterature: MacCallum et al., Brit. Jour. Exp. Path., 20, 1939, 260-269.

4. Leglo muris spec. nov. From Latin mus, mouse.

nus, mouse.

Common names Mouse-poliomyelitis

virus, Theiler's disease virus.

Host MURIDAE-Mus musculus L.,

white mouse
Insusceptible species CERCO-

PITHECIDAE—Macaca mulatia (Zimmermana), rhesus monkey. Geographical distribution: United

States, Japan, Germany, Palestine; probably widespread wherever white mice are 'raised.

Induced disease. In white mouse, ordinarily no obvious disease, virus oceurring in feees and not being recoverable from thoracie or abdominal viscera or head (probable source is in abdominal wall, virus has been recovered most abundantly from intestinal contents, in moderate amounts from walls of intestine and in smaller concentration from mesenteric lymph glands), occasionally, individual mice show flaceid paralysis of land legs, and brain or spinal-cord suspensions from these contain the virus. mice morulated intracerebrally show flacerd purily sis in 7 to more than 30 days. first to one limb, later usually in all , the tail does not become paralyzed, very young use ulated mice may die without first showing paradysis, very old moculated mice may become infected without showing obvious disease, some affected mare recover and those showing residual paralysis may become carriers of virus In affected, experimentally snoculated mice, arute premais of gargion cells of anterior born of spinal cord, necrosis also of sadated gangleon cells of cerebrum. Inter, marked neuronophagia. Perivascular infiltration in brain and spinal cord.

The reciprocal of the incubation period has been found approximately proportional to the logarithm of the amount of virus inoculated, thus serving to measure the concentration of samples of virus. Old mice least susceptible than young.

Transmission. Experimentally, by intracerebral, intransal and intraperitorneal inoculation. Has been found to persist in adult flies, Mucca domestica L. (MUSCIDAE) and other species, as long as 12 days after experimental feeding whereas mouse-adapted buman poliomychitis virus persists only 2 days in Muca domestica and not at all in some other species.

Serological relationships. Sera containing antibodies to the Lansing strain of human poliomyelitis virus fail to protert arainst mouse poliomyelitis virus.

Immunological relationships: Recovered mace are immuno to various beterologous isolates or strinis. No evidence of immunological relationship with yerus of human polomyelitis has been obtained, save that mice paralyzed with mouse polomyelitis virus show some resistance to infection with the Lanaing strain of human polomyelitis virus, this has been interpreted as possibly no more than an interference phenomenon, since it seems to depend on actual pr. 1 yess.

Filterability Passes Berkefeld N and other Berkefeld filters and Chamberland La filter

Other properties Viable at least 14 months at -75° C, at least 150 days in 150 days in 50 per cent glycerine at 2 to 4° C. Most stable near pll 8 00 and pll 33. Inactivated readily at 37° C by 1 per cent hydrogen perovide. Particle dameter estimated as 9 to 13 millimeroms from fittenion atudies. Sedimentation constant, S<sub>15</sub>° = 100 to 170 × 10<sup>-13</sup> cm per eec. per dyne.

Literature Bang and Gluser, Am. Jour. Hyg. 37, 1912, 320-321, Golacan and Stevenson, Jour Inf. Dia., 62, 1911, 232-237, Gard, Jour. Exp Med., 72, 1910, 60-77, Gard and Pedersen, Science, 94, 1911, 433-403, Gildemeiter and Ahlfeld. of rabid horses or cattle. Not by contamination of food. In Brazil and Trinidad, probably by the vampire bat, which has been found infected in nature.

Serological relationships: Specific flocculation of rabies virus occurs in the presence of immune serum from rabbit or guinea pig; strains differ in relative amounts of antigenic constituents, as shown by absorption tests. Complement fixation occurs in the presence of virus and guinea-pig antiserum. Neutralizing antibodies are specific.

Immunological relationships: Virus exposed to ultraviolet light tends to bese its virulence before its immunizing potency. Passive immunization succeeds in white mice if antiscrum is injected infracershiply how before, but not 24 hours before or 2 hours after, virus. Chloroformicated vaccines more effective than phenolized vaccines, but irritative.

Thermal inactivation: At 60 to 70° C in 15 minutes; in brain tissues, at 45° C in 21 hours.

Filterability: Passes Berkefeld V filter. Other properties: Viable at least 2 months at 5° C in liquid or dry state. Infective particle between 190 and 240 millimicrons in diameter, by filtration studies.

Literature: Bernhopf and Kligler, Brit. Jour. Exp. Path. 18, 1937, 481–485; Casals, Jour. Exp. Med., 72, 1940, 445–451, 483– 461, Covell and Danks, Am. Jour. Path., 8, 1932, 557–572, Dawson, Science, 82, 1939, 300–301; Am. Jour. Path., 17, 1941, 177–188, Galloway, Brit. Jour. Exp. Path., 15, 1934, 97–105, Goodpasture, Am. Jour. Hyg., 1, 1925, 547–582; Haupt and Rehang, Zitschr. f. Infektionskrank., 22,

1921, 76-88, 104-127; Havens and Mayfield, Jour. Inf. Dis., 50, 1932, 367-376; 51, 1932, 511-518; 52, 1933, 364-373; Henderson, Vet. Med., 37, 1942, 88-89; Hodes et al., Jour. Exp. Med., 72, 1940, 437-444; Hoyt et al., Jour. Inf. Dis., 59, 1936, 152-158; Hurst and Pawan, Lancet, 221, 1931 (2), 622-628; Jour. Path. and Bact., 35, 1932, 301-321; Johnson and Leach, Am Jour. Hyg., 32 (B), 1940, 38-45; Kligler and Bernkopf, Proc. Soc. Exp. Biol, and Med., \$9, 1938, 212-214; Am. Jour. Hyg., 25 (B), 1911, 1-8; Leach and Johnson, ibid., 32 (B), 1949, 74-79; Metivier, Jour. Comp. Path. and Therap., 48, 1935, 245-260; Peragallo, Giorn, di batteriol, e immunol., 18, 1937, 289-290; Snyman, Oaderstepoort Jour. Vet. Sci. and Anim. Indust., 15, 1949, 9-140; Webster, Am Jour. Pub. Health, 26, 1938, 1207-1210; Jour. Exp. Med., 70, 1939, 87-106; Am. Jour. Hyg., 50 (B), 1939, 113-134; Webster and Casals, Jour. Evp. Med., 71, 1910, 719-730; 73, 1911, 601-615; 78, 1912, 185-194; Webster and Clow, 18id, 66, 1937, 125-131; Wyckoff, Am. Jour. Vet. Res., 2, 1941, 84-90.

Note: The Negri body, a characteristic cell-inclusion in rables, has been given the following names under the supposition that it represents stages in the life cycle of a protocoan varsatic responsible for the disease: Neurorytes hydrophotae by Calkins, Jour, C. \*aneous Diseases including Syphilis, 25, 1907, 519, Encephaltocoon rable by Manouelian and Visla, Ann. Inst. Pasteur, 38, 1924, 235, and Glupca tyssae by Levaditt, Nirolau and Schoen, Ann. Inst. Pasteur, 49, 1926, 1048

Serological relationships. Serum from recovered cases neutralizes the virus Immunological relationships: Specific immunity follows attack of the disease Differability Passes Chamberland L<sub>2</sub> filter Literature: Durand et al., Compt. rend. Acad. Sci., Paris, 203, 1936, 830-832, 957-959, 1632-1634; Arch. Inst. Pasteur de Tunus, 26, 1937, 213-227; 228-249, 27, 1938, 7-17.

#### Genus III Formida gen. nov.

Viruses of the Rabies Group, inducing diseases characterized by involvement of the nervous system only Generic name from Latin formulo, a frightful thing The type and only recognized species as Formulo uncombits spec now

1 Formide inexorabilis spec. 1100. From Latin snexorabilis, implacable Common name Rabies virus

Hosts CANIDAE-Cants familiaris L., dog FELIDAE-Felia catua L., domestic cat . F negripes, black-footed cat . F ocreata, wild cat, HOMINIDAE-Home samens L., man, MUSTELI-DAE-letonuz orangiae, polecat URIDAE-Geosciurus capensis, ground VIYERRIDAE-Cymietis penicillata, Sellow morgoose (rellon meerent), Genetta felina (Thunb ), genet cat, Myonar pulcerulenius, small, grey nin impre. Suricata suricata. Cape suricate or common meercat Cattle, sleep, nig horse, welf Cynalopez chama, nilver rackal Phyllostoma superciliatum, vammre bat, Dismodus rufus, vammre bat, Artibeus planicasteis trimitatie, fruit-ent Lypermentally, also Mus musing but culus I., white mouse, Peromuscus policinotus polionotus (Wagner), white footed mouse, tissue cultures of 5 or 6-day-old ent or mouse-embryo brain, chick embryo fallantois not regularly inferted. but vir is regularly reaches brain of embeen without mairing it, chick may batch with fiter of 1 100 or 1 1000 in brain) Chirken . mouse hank (Buteo vulgaris); prgron, owl, goose, stork (Ciconia ciconia). phoseint (Diardian'lux diardi BP)

Instrocptible spaces Reptiles, fish No mammatis known to be mausceptible. Geographical distribution Almost world wide, absent only from relatively polated countries or communities.

Induced docume In deg, after a short

incubation period (generally less than 10 days) altered behavior, hiding, lack of obedience, perverted appetite leading to ingestion of straw, paper, earth, and other unrecustomed materials, excitement, unprovoked biting (which may transmit the virus to new hosts), simless wandering, excess salivation, progressive inability to swallow, alteration of bark to characteristic high pitched tone, staggering, paresis of hindeparters tending toward paralysis and involvement of anterior parts of the body, paralysis of lower jaw, muscular spasms, marked emacration, death except perhans in rare instances. In man, after a relatively long incubation period depending on site of implantation (perhaps 27 to 61 days), a uniformly fatal disease. characterized by altered behavior, increased excitability, thirst, pharyngeal spasm with progressive mability to swallow. Inhored and poisy respiration, death in 3 or 4 days after onset, with or without corovers. In sheep, mereased sevual deure, tendency to pull wool from other sheep or themselves; light butting, increasure until some eves, after violent exercise, appear to faint, prostration within I to I days, death within 2 days. from onset of locomotory paralysis. In mouse, experimentally, by intracerebral moculation, apathy, sluggishness, roughening of hair, tremer, consulsions, prosdeath, sometimes paralysis of hand legs before death. Transmission Usually by bite of doe

or some closely related animal, occasionally by bites of cats, rarely by bites Litmus milk: Acid, not digested.. Potato: No apparent growth.

Indole is formed.

Nitrites produced from nitrates.

Ammonia is produced. Acid from glucose, lactose, maltose,

sucrose and starch.

Aerobic, facultative.

Optimum temperature 20°C. Habitat : Soil.

49 Pseudomonas tralucida Kellerman et al. (Kellerman, McBeth Scales and Smith, Cent. f. Bakt., II Aht , 59, 1913, 37; Cellulomonas tralucida Bergey et al., Manual 1st ed., 1923, 163) From Latin, clear, transparent.

Rods 0.6 by I 2 microas. Motile with one or two polar flagella. Gram-negative. Golatin stab: No liquefaction.

Agar slant: Scant, grayish growth.

Broth · Turbid.

Litmus milk: Acid,

Potato: No growth.

Indole not formed. Nitrites produced from aitrates.

Ammonia not produced

Acid from glucose, maltose, lactose,

sucrose, starch, glycerol and mannitol. Acrobic, facultative.

Optimum temperature 20°C.

Habitat: Soil.

50 Pseudomonas mira McBetlı. (Mc-Beth, Soil Science, 1, 1916, 437; Cellulomonas mira Bergey et al., Manual, 1st ed., 1923, 165.) From Latin, mirus, wonderful, extraordinary.

Rods: 0 4 by 16 microns. Motile with a single polar flagellum. Gram-negative. Gelatin stab: Good growth. No lique-

faction.

Agar colonies: Circular, convex, grayish-white, granular, lacerate

Agar slant: Moderate, flat, grayishwhite, somewhat iridescent.

Broth: Turbid.

Litmus mılk: Alkaline. Potato Moderate, grayish-white. Indole not formed.

Nitrites produced from nitrates. Ammonia is produced.

Acid from glucosc, maltose, lactose, sucrose, starch, glycerol and mannitol.

Aerobic, facultative.

Optimum temperature 20°C. Habitat: Soil.

51. Pseudomonas lindneri Kluyver and Hoppenbrouwers. (Lindner, 50 Ju-Bot. Zool. biläumsber. Westpreuss. Vereins, 1928, 253; Termobacterium mobile Lindner, Atlas d. Mikrosk. Grundl. d. Garuagsk., 3 Aufl., £, 1928, Taf. 68; Kluyver and Hoppenbrouwers, Arch. f. Mikrobiol., 2, 1931, 259; Achromobacter mobile Kluyver and Hoppeabrouwers, ibid., 258; not Pseudomonas mobilis Migula, Syst. d. Bakt., 2, 1900, 923.) Named for Lindner, the German hacteriologist who first studied this organism.

Short rods 1.4 to 2.0 by 40 to 50 mierons. Occurring singly, in pairs and short chains. Motile with a single polar flagellum. Gram-negative.

Peptone gelatin: Poor growth. Peptone agar: Poor growth.

Wort agar: White, round, raised colonies, 1 mm. in diameter. Good growth Still better where 2 per cent sucrose, or yeast extract with sucrose is added. Chalk added to neutralize acid.

Broth: Poor growth in peptone or yeast extract broth unless sugars are added.

Carbon dioxide, ethyl alcohol and some lactic acid produced from glucose and fructose, but not from mannose. May or may not ferment sucrosc. May produce as much as 10 per cent slcohol.

Catalase produced.

Anaerobic, facultative. Optimum temperature 30°C.

Distinctive character: The fermentation resembles the alcoholic fermentation produced by yeasts.

Source: Isolated from the fermenting sap (pulque) of Agave americana in Mexico.

Habitat. Fermenting plant juices in tropical countries (Mexico).

### FAMILY IV. CHARONACEAE FAM. NOV.

Viruses of the Yellow-Fever Group, inducing diseases mainly characterized by fever and necrosis of tissues in the absence of obvious macule, papule, or vesicle formation or of conscious involvement of nerve cells.

### Key to the genera of family Charonaceae.

I Viruses of the Typical Yellow-Fever Group.

Genus I. Charon, p 1265.

Genus II Tarpeta, p 1268.

III. Viruses of the Hog-Cholera Group Genus III. Tortor, p 1275.

### Genus I. Charon gen nov.

Viruses of the Typical Yellow-Fever Group, inducing diseases mainly characterized by acute non-contagious fever. Vectors depterous insects, so far as known. Generic name from Latin Charon, ferryman of the Lower World.

The type species is Charon eragatus spec nor

#### Key to the species of genus Charon.

I Vectors mosquitoes

1. Charon et agatus.

II Vectors unknown, perhaps mosquitoes

2 Charon tallia

# 1, Charon evagatus spec, nor. Trom

Common name Yellon-fever virus
Hosts HOMINIDAE—Homonapiers
Li, man. Experimentally, also Cereopithecus fantalus Oxilby, C. aethops,
Mirtan guteno (symptomless), Cereocelus forquetus (Kerr), collared mangabey; Mus musedus L. mouve, Mierobus
agrestis, field sole, Sciurus valgaris L.,
red squirrel, Macaro mulotta (zimmer
mann), thesus monkey, Macacas sinicus
Indian crown monkey, W. cynomolgus,
M. speconic, Erinaccus acropacus, helpe
bey, Gallies gallies (L.), clacken (tal
rmnt), Disapprocta quit, apunti (serra).

Insusceptible spaces (at, ferret, ribbit, rit, Crectus aventus, golden kanster, Apochemu splaticus, need vole, Frotomys glariolus, bank vole; pigean, catary, pipustrelle lat, Crecturgs gambanus, postched rat, deg. grat.

messer faile?

Geographical distribution. Troplent re-

gions in general, especially Central and South America, West Indies, West Africa, anti-meetatto campaigns have tended to eradicate yellow-fever virus Irom parts of its forcest range.

induced disease. In man, mild cases may occur, especially to natives where the disease is endemic, but in Europeans cenerally sudden fever without marked chappee in suitee rate after a 3 to fallay inculation period, severe frontal headache, mins in the loin and lers and enigastrie pain, gradual decrease in temperature to 9% or 99" I', weakening of pulse and skiwing of heart beat in the abence of further temperature changes; rundice, especially in sclerae, often in skin, albumen in urine, later bile-pigmentaalso present , bemorriages frequent especially in alimentary canal; fatty and tocrotse changes in the liver; acute degeneration of renal parenchs ma, aplenic congestion; death may occur in the early acute state, but is more likely about the fifth or sixth day; relapses may occur until 2 or 3 weeks after onset; case mortality varies from 10 to 90 per cent in different epidemics. A transitory immunity due to transfer of serum antibodies through the placents protects offspring of immune mothers for a short time.

Transmission: By mosquitoes, Aëdes aegypti L., Aèdes leucocelaemus (D. and S.), Haemogogus capricorna Lutz (CULICIDAE). The mosquito Aides aegypti becomes infective, after feeding on a suitable virus source, in 4 days at 37° C, 5 days at 36° C, 6 days at 31° C, 8 days at 25.1° C, 9 to 11 days at 23.4° C, 18 days at 21° C, and 36, not 30, days at 18° C; virus in head, thorax, and abdomen before bites are infective; no evidence of transmission of virus through eggs to offspring or to larvae eating infected adults. Experimentally, also by Aêdes scapularis (Rondani), A. fluviatilis (Lutz), A. lutcoccphalus, A. opico-annulatus (CULICIDAE). Experimentally, by feeding, to Macaca mulatta and Cerconithecus octhiops; by rubbing infected blood into intact and unshaved skin of monkeys.

Serological relationships Complementfixation and precipitating antibodies are specific.

Immunological relationships: A specific immunity develops after an attack of the disease or after vaccination with virus grown in media containing tissues of chick embryo minus head and spinal cord.

Thermal inactivation: At 55 to 60° C, not at 50° C, in 10 minutes

Filterability Passes membranes of 55, and to some extent membranes of 50, millimicron average pore diameter. Passes Berkefeld V and N, as well as Chamberland F, filters.

Other properties: Particle estimated from filtration data to have a diameter of 17 to 28 ruillimicrous; by ultracentralugation data, 19 millimicrons. Inactivated or inhibited by 30-minute exposure to 1:15 formalin, 1.6 ethyl afcohof; 1:300

yellowish cosin, 1:50 sodium oleate, 1:200 liquor cresolis compositus; viable after 39-minute exposure at 20° C to 1:7500 mercuric chloride, 1:150 phenol, 1:1500 heavylresoreinel, 1:150 sodium oleate. Sedimentation constant between 18 and 30 × 10<sup>-13</sup> cm per sec. per dyne. Viable in 50 per cent glycerine at 2 to 4° Co for 18, not for 100, days; in mouse brain at -5° C for 160 days. Viability may be lost on simple drying but retained if drying is carried on in vacuo over a desicating agent.

Strains: Distinctive strains have been isolated. One, to which much study has been given, differs from the typical viscorotropic strain by possessing marked neurotropic or pantropic characteristics.

Literature · Bauer and Hughes, Am. Jour. Hyg., 21, 1935, 101-110; Bauer and Mahaffy, 16id., 12, 1930, 155-174; 175-195; Bugher and Gast-Galvis, 181d., 59, 1944, 58-66; Bugher et al., sbid., 59, 1944, 16-51; Davis, abid., 16, 1932, 163-176; Davis and Shannon, 1bid., 11, 1930, 335-344, Davis et al., Jour. Exp. Med., 68, 1933, 211-226; Findlay, Jour, Path. and Bact., 58, 1934, 1-6; Lancet, 227, 1934 (2), 983-985; Findlay and Clarke, Jour. Path. and Bact., 40, 1935, 55-64; Findley and MacCallum, Brit. Jour. Exp. Path., 19, 1938, 384-388; Jour. Path. and Bact., 49, 1939, 53-61; Findlay and Mackenzie, ibid., 45, 1936, 205-208; Findlay and Stern, ibid., 40, 1935, 311-318; Fox and Cabral, Am. Jour. Hyg., 57, 1943, 93-120; Frobisher, Am. Jour. Hyg., 11, 1930, 300-320; 15, 1931, 585-613; 14, 1931, 147-148; 18, 1933, 354-374; Goodpasture, Am. Jour. Path., 8, 1932, 137-150; Hasgen, Deutsch. med. Wochnschr., 60, 1934, 983-983; Hudson, Am. Jour. Path., 4, 1928, 395-430; Klotz and Simpson, abid., 3, 1927, 483-488; Lacamert and Moussatché, Jour. Inf. Dis., 72, 1943, 228-231; Lloyd et al., Am. Jour. Hyg., 18, 1933, 323-344; Trans. Roy. Soc. Trop. Med. and Hyg., 29, 1935, 481-529; Mahaffy et al., Am. Jour. Hyg., 18, 1933, 618-628; Pickels and Bauer, Jour. Exp. Med., 71, 1910,

703-717; Ramsey, Am. Jour. Hyg., 15, 1931, 129-163; Sawyer, ibid., 25, 1937, 221-231: Shannon et al . Science. 68 1938, 110-111; Smith and Theiler, Jour. Evo. Med., 65, 1937, 801-808; Smith et al , Am Jour. Trop. Med., 18, 1933, 437-463. Soper and De Andrade, Am, Jour Hyg. 18, 1933, 588-617; Soper et al , 151d., 18, 1933, 555-587; 19, 1934, 549-566, 27, 1938, 351-363. Stefanopoulo and Wassermann, Bull. Soc Path. Evet , 26, 1933, 557-559 Stokes et al., Am. Jour. Trop. Med., 8 1928, 163-164, Theiler, Ann. Tron. Med and Parasit., 24, 1930, 249-272, Thesler and Smith, Jour. Evp Med , 65, 1937, 767-786, 787-800, Whitman, abid., 66. 1937, 133-143,

2. Charon vallis spec, nov. From La-

Common name Rift Valley fever virus Bosts HOMINIDAE-Home samens L., man. BOVIDAE-Ros taurus L. cow: Ons aries L . sheep. Capea hireut L. goat Experimentally, also Sciurus carolinensis, grev squierel, ferret, Cricetus auratus, golden hamster: Anodemus aniratious, wood mouse. Microtus agreetie field vole, Museardinus acellanarius, dormonse, rat, mouse, Macaca mulatta, M. trus, Cebus fatuellus; C. chrusopus; Havale racehus; Il penicillata; Cerconethecus callifrichus (avenniomiers). Centhrocebus patas (symptomices): Cercocebus fuliminosus (symptomicss), chick embryo in Tyrode's solution, chorioallan tole membrane of chick embryo

Insusceptible species Horse, pig Geographical distribution British East Africa.

Induced disease In man, beingen discase, after 51 to 6 days, rigors, pains in beck, fever for 12 to 36 hours, followed by recovery, with persistence of acquired immune bodies as long as 4 to 5 years after infection. In sleep (laintes), dullness, rapid respiration, collayee and death in a few hours or a chromic course, focal necrosis in liver. In chorsollantoic membrane of ethels embryo, entertiment

tally, areas of hyperplasia and of necrosis; connective tissue inflamed nearby; liver of embryo mottled with necrotic areas.

Transmission: Not by contacts. Moqquito, Teniorhynchus breupalpis (CUL-ICIDAE), suspected as possible vector. Scrological relationships Antisera for prittacous, dengue fever, and sandly fever viruses fail to protect against infection with Bit Valley fever virus. Specife neutralizing antibody in intraperitoneally neutral mysture with Bit Valley fever virus may be dissociated so as to free virus my direct dilution in saline solutions, by intransal inoculation, or by employment of a small dose, all methods nowishly implying a dilution effect.

Immunological relationships: No cross immunity with selion-fever or dengue-facer viruses. If Rift Valley fever virus is smoulated into rheus monkey simultaneously with yellow-fever virus, the animal tends to be protected against death from yellow fever (interference effect), but one-day carlier inoculation of Rift Valley fever virus does not protect

Thermal mactivation At 56° C in 40, not 20, montes.

Filterability: Passea Berkefeld V, X, and W filters; passe Chamberland La, La, La, La, and occasionally Ln filters, passes membranes 150 millimerons in average price diameter freely, 90 millimerons with difficulty, 70 millimerons and at all

Other properties Viable at least S months at 4°C, more than 4 weeks dry in liver tissues, 6 months in § per cent carbohe acid at 4°C. Diameter of infective private estimated from filtration studies to be between 23 and 35 millimiterops.

Strains A neurotropic strain imnumizes lambs without producing obvious cliness, if given subcutaneously

Literature Broom and Findlay, Brit. Jour Exp Path, 14, 1933, 170-181; Daubney et al., Jour. Path, and Bact., 24, 1931, 545-579; Findlay, Trans. Roy.

Soc. Trop. Med. and Hyg., 25, 1932, 229-266; 26, 1932, 157-160; 161-168; Brit. Jour. Exp. Path., 17, 1936, 89-101; Findlay and MacCallum, Jour. Path, and Bact., 44, 1937, 405-421; Findlay and Mackenzie, Brit. Jour. Exp. Path., 17, 1936, 411-447; Findlay et al., ibid., 17, 1936, 431-441; Francis and Magill, Jour. Exp. Med., 62, 1935, 433-448; Horning

and Findlay, Jour. Roy. Micr. Soc., 54, 1934, 9-17; Mackenzie, Jour. Path. and Baet., 57, 1933, 75-79; 40, 1935, 65-73; Mackenzie et al., Brit. Jour. Exp. Path., 17, 1936, 352-361; Saddington, Proc. Soc. Exp. Biol. and Med., 31, 1934, 693-694; Schwentker and Rivers, Jour. Exp. Med , 59, 1931, 305-313,

## Genus II. Tarpela gen. nov.

Viruses of the Influenza Group, inducing diseases characterized principally by involvement of the respiratory tract. Generic name from Latin Torpeia, name of a Roman maiden who treacherously apened a citadel to an enemy.

The type species is Tarpeia alpha spec. nov.

## Key to the species of genus Tarpela.

- I. Infecting man principally.
- 1. Tarpeia alpha. 2. Tarpeta bela.
- II. Afferting feline species.
- 3. Tarpeia premens. 4. Tarpeia felis
- III. Affecting domestic cattle (calves).
- IV. Affecting canine species.
- 5. Tarpera ritulae.

V. Affecting ferrets.

- 6. Tarpeia canis. 7. Tarpera vulpis.
- VI. Affecting domestic fowl.
- 8. Tarpeia viverrae.
- 1. Tarpela alpha spec, nov. From first

letter of Greek alphabet Common name Influenza A virus; 9. Tarpeia arium.

swine filtrate-disease virus. Hosts: HOMINIDAE-Homo sapiens

Insusceptible species: Callosciurus caniceps canigenus Honell, Chekiang squirrel; Eutamias asiaticus tenescens Miller, chipmunk.

L., man SUIDAE-Sus scrofa L., domestic swine. Experimentally, also ferret, mouse, Macacus irus, hedgehog, rabbit (inapparent infection), guinea pig (inapparent infection), rat (inapparent infection); Mustela siburica Milne-Edwards, Chinese mink; Sciurotamius davidianus Milne-Edwards, David's squirrel, chick embryo (some strains produce visible lesions at 36.5° C on choricaliantoic membrane); minced chick embryo in Tyrode's solution.

Geographical distribution : World-wide. Induced disease: In man, headache, dizziness, with shivering and muscular pains; rise of temperature on the second day, sometimes with fall on the third and elevation again later; often complicated by bronchitis and bronchopneumonia; hemorrhagic and edematous lobular consclidation in lungs; virus most easily recoverable from nasophary ngeal washings, but also from nasal secretions and lungs. In swine, virus alone produces only a mild malady (filtrate disease);

in the presence of Haemaphilus influenzae sure a severe maindy occurs under both natural and experimental conditions; it involves fever, cough, and prostration; many infected animals die. Lungworms, Metastrongulus elongaius and Choeropudendotectus GIETAstrongulus STRONGYLIDAE). from infected su inc barbor virus at least 2 years, living meantime in earl buorms, such as Allolobophora caliginosa (LUMBRICIDAE), which are eaten eventually by swine. The swine are refractory to viral infection during May, June, July, and August, but the disease may be invoked later by successive intramuscular aniections of Hormophilus influenzae suis or other stimuli, such as feeding embrionated iscaris ova In infected swine, virusoccurs in turbinates, tracheal evodates, and hings, not in spleen, liver. Lidnes. mesentene ir meh nodes, brain, blood, or mucosa of colon Neutralizing antibodies annear later (7th to 10th day) in the mild filtrate disease than in typical swine influenza, in which they appear about the 6th to the 7th day, maximum titer on 11th to 27th day. Experimentally in mouse, not contagious as in sauce and not dependent on the coexistence of a toutered commonent, death of contbellum of respiratory and terminal bronchioles. consulcte epithelial desquamation, dilata two of homeholes, collanse of alsech, an healing, widespread emthelial problem. Experimentally in ferret, mod erate apathy, lack of appetite, pallor of mose, variable entarrhal symptoms, at acute stage of disease, necessis of resourators epithelium of assal miteous mem brane, with disquantion of superficial cells exudation into air passages and and amounted traction in the animucus. repoir follows, beginning on the 6th disafter infection and becoming essentially complete at the end of 1 month, after money the ferret is namine for 3 mently or now with subscapent names of resistance, subsequent subsutaneous invalidations of tirus restore immunity. Transmission: Presumably by droplets; for example between eages of ferrets as a close as 5 feet apart, even to levels 3 feet higher than eage of diseased individusls. Experimentally, from washings of human throats to ferret, mouse, chick embryo (by amniotic route and to allantoic membrane); in mice, by contact and by industion of fine droplets.

Semiorical relationships: Neutralizing antibodies common in human sera from individuals above 10 years of age; rarer in sera from young children; strongly effective for homologous, weak for heterologous, virus in convalescent sera. Soluble complement-fixing antigen of snine strain has components in common with antweens of human steams (PRS and WS). Complement fixation best 10 to 14 days after onset in man. Inactivating capacity of masal secretions proportional to level of neutralizing antibodies in blood. Aggiutination of red cells by influenza virus is inhibited quantitatively by Absence antisecum.

Immunological relationships. Specific immunitation of ferrets, without obvouce disease, ocrurs as a result of intransaci morulation of egg-passage influenta virus that is not transmissible from ferret to ferret. In mee, immunitang dose is directly purportional to degree of induced immunit, immunity to the atrain used an immunitation is more effective in general than that to beterologists isolates of the virus.

Filtersblity Basses Beckefeld V Siter. ther properties Parview me estiuated at \$0.00 120 millimerons by filterteen studies, \$0.00 20 millimerons by ultracentrifugation (\$5.5 - 721 × 10°11) cm per sec per dyne), electron merographs slow bean or kidney-shaped particles, or cound porticles with central dense syst, averaging 7.6 millimierons in disuncter Instituted by olcie, hooke and hisedems earls without loss of immuniang ability. Inscitiated by ultraviolet radiation

Laterature Andrewes and Glover,

Brit. Jour. Exp. Path., 22, 1941, 91-97; Andrewes et al., ibid., 16, 1935, 566-582. Burnet, ibid., 17, 1936, 282-293; 18, 1937, 37-43; 21, 1940, 147-153; Austral. Jour. Exp. Biol. and Med. Sci., 14, 1936. 241-246; 19, 1941, 39-44, 281-290; Eaton. Jour. Bact., 39, 1940, 229-241; Eaton and Pearson, Jour. Evp. Med., 72, 1940. 635-643; Enton and Rickard, Am. Jour. Hyg., 55, (B), 1941, 23-35; Elford et al., Brit. Jour. Exp. Path., 17, 1936, 51-53; Francis, Science, 80, 1934, 457-459; Jour. Exp. Med., 69, 1933, 283-300; Francis and Magill, Science, 82, 1935, 253-354; Brit. Jour. Exp. Path., 19, 1938, 281-293; Francis and Shope, Jour. Exp. Med., 68, 1936, 645-653; Francis and Stuart-Harris. ıbid., 68, 1938, 789-802; Francis et al., Am. Jour. Hyg., 37, 1943, 294-300; Hirst. Jour. Exp. Med., 75, 1942, 49-64; Hirst et al., ibid., 75, 1912, 495-511; Proc. Soc. Exp. Biol. and Med., 50, 1942, 129-133; ... Tone Den Mod

1942, 338-353; Lennette and Horsfall, Jour. Exp. Med., 78, 1941, 591-599; Locali et al , Jour Inf. Dis., 72, 1943, 142-153: Lush and Burnet, Austral. Jour Exp. Biol and Med. Sci., 15, 1937, 375-383; Magili and Francis, Brit. Jour Exp. Path , 19, 1938, 273-284; Nigg et al , Am, Jour. Hyg., 54 (B), 1941, 135-147; Orgutt and Shope, Jour. Exp. Med., 62, 1935, 823-826; Rosenbusch and Shope, abid., 69, 1939, 499-505; Shope, abid., 69, 1934, 201-211; 62, 1935, 561-572, 64, 1936, 47-61; 67, 1938, 739-748, 74, 1941, 41-47. 49-68; 77, 1943, 111-126, 127-138; Shope and Francis, ibid., 64, 1936, 791-801; Smillie, Am. Jour. Hyg , 11, 1930, 392-398; Smith et al., Lancet, 225, 1933 (2), 66-68, Brit. Jour. Exp Path . 16, 1935, 291-302; Smorodintseff and Ostrovskaya, Jour. Path. and Bact., 44, 1937, 559-566; Stock and Francis, Jour. Evp. Med., 71, 1940. 661-681; Stray's, Jour. Path. and

Dis., 69, 1941, 278-284; Tang, Brit. Jour. Exp. Path., 19, 1938, 179-183; Taylor, (A. R.), et al., Jour. Immunol., Virus Res. and Exp. Chemother., 47, 1943, 261-22; Taylor, (R. M.), et al., Am. Jour. Hyg., 51, (B), 1940, 36-45; Jour. Inf Dis., 68, 1941, 90-96; Wells and Brown, Am. Jour. Hyg., 24, 1936, 407-413.

Tarpela beta spec. nov. From second letter of Greek alphabet.

L.,

mouse, chick embryo.

Geographical distribution: United States, England.

Induced disease: In man, subclinical disease or one resembling that induced by influenza A virus. In chick embryo, experimentally, virus increases in endermal cells lining allantoic cavity.

Serological relationships: Not neutralized by antiserum to influenza A virus. Specific neutralization and complementfration reactions. Rapidly adsorbed by normal chicken-blood red cells (55 per cent in 15 minutes), released in 4 hours essentially completely; the process is then repeatable with fresh red cells.

Other properties: Partiele circular or bean-shaped in outline, with average diameter of 97.3 millimerons in electron micrographs; of 99.8 millimierons by centrifugation studies.

Laterature Burnet, Austral. Jour. Exp. Biol. and Med. Sci., 18, 1911, 291-295; Francis, Science, 28, 2019, 694-698; Prec. Soc. Evp. Biol. and Med., 45, 1919, 861-863; Hirst, Jour. Exp. Med., 76, 1912, 195-200; Lush et al., Brit, Jour. Exp. Path., 23, 1911, 302-304; Nieg et al., Am. Jour. Hyg., 53, 1912, 295-294; Sharpet al., Jour. Lamounol., Virus Res. and Exp. Chemother., 48, 1944, 129-153.

3. Tarpela premens spec. nov. From

irus apiens L. man. Experimentally, also chimpanzee, chick embrao.

Geographical distribution: World-wide except in conditions of isolation of small communities

Induced disease In man, incubation period about 48 hours; raild malady; running nose in \$1 per cent of cases, obstruction of nostrils in 44 per cent, sudden onset in 37 per cent, cough in 31 per cent, headache in 19 per cent, sore throat in 14 per cent, fever in 13 per cent, inflammation of eyes in 12 per cent; changes in weather, especially during a warm season, predispose to the disease, no correlation beingen ausceptibility and outdoor exereise, exposure to fresh air while elceping. eye color, adenotonsillectomy, or size of frontal sinus. Incidence inversely proportronal to daily hours of sunshine and atmospherie temperature. Fitness (defined by speed of oxygen replacement) correlated with relative freedom from Effect of rest during disease favomble, reducing complications, length of fever, duration of illness, and period off duty

Immunological relationships: After attack, specific immunity for about 7 weeks (minimum period 23 days), then exposure to chilling may cause a relapse, but an isolated community tends to lose the virus during the refractory period

Lilterability Passes Berkefeld V and Was nell as Settz filters.

Other properties Viable at least 13 days at ice box temperature, anaerobically , at least 4 months frozen and dried in racuo Gum acacia tends to stabilize virus in chick-embryo tissue medium

Laterature Doches et al . Jour. Esp. Med . 63, 1936, 659-579, Doult et al . Am Jour Hyg., 13, 1931, 460-477, 17, 1933, 536 561, Cafaler, chief. 15, 1931, 771-750, 16, 1932, 233-210, 550-554, Jour Inf Dis , \$1, 1932, 149-192, Gefafer and Doubl, Am Jour Hyg , 18, 1933, 712-726. Hydr and Chapman, and , 20, 1937, 116-123, Roccland et al., Proc. Soc. Exp. Biol and Med. 55, 1936, 213-215, Le

Blane and Welborn, Am. Jour. Hyg., 24, 1936, 19-24; Locke, Jour. Inf. Dis., 60, 1937, 106-112; Long and Doull, Proc. Soc. Exp. Biol. and Med., 28, 1930, 53-55 Maughan and Smiley, Am. Jour. Hyg., 9 1929, 466-472; Noble and Brainard, Jour. Bact., 29, 1935, 407-409, Palmer, Am. Jour. Hyg., 16, 1932, 221-232, Paul and Freese, stid , 17, 1933, 517-535; Shibley et al., Jour. Am. Med. Assoc., 95, 1930, 1553-1556; Smiley, Am. Jour. H3g., 6, 1926, 621-626, 0, 1929, 477-479.

4. Tarpela fells spec. nov. From Latin feles, cat

Common name . Tehne-distemper virus.

Hosta . FELIDAE - Felia caina L., domestic cat F. pardus leopard : F. trgring, American tiger cat, F. gurato, African there eat: F. planiceps, rusty timer cat: F. marmorata, marbled ent; F. caracal, caracal lynx; F. pardairs, occlot; lion. tiger, puma relatively insusceptible.

Insusceptable species Man, dog, ferret, monecose, rabbit, rat, mouse, guinea pig.

Induced disease In domestic cat. coughing, angeging, running eyes and nose, with scrous or purulent conjunctivitas, or diarrhea and somiting, fever to 103 or 105° F; loss of appetite, general weakness, mortality high, especially omong young under ideals, death usually occurs on the 10th to the 12th day, in extreme cases, however, as early as the 5th or as late as the 35th day, catarrhal congestion in some part of the gastrointestinal tract is typical, this ranges from a few small patches in the ileum to involvement of the whole small intestine and parts of the large intestine or stomath and esophagus, often enlarcement and congestion of abdominal lymph glands, enlargement of spicen, pleurisy, and personsus

Filterability Passes Perkeleld N and Chamberland L. filters.

Transmission By lomite s. Immunological relationships: Recor-

ared cats specifically immune.

Other properties: Viable at least 3 weeks in 50 per cent glycerine; attenuated or killed by drying at room temperature, but some immunization is reported if dried virus is injected.

Literature: Dalling, Vet. Record, 15, 1935, 283-289; Findlay, Vet, Jour., 89, 1933, 17-20; Hindle and Findlay, Jour. Comp. Path. and Therap., 45, 1932, 11-26; Verge and Cristoforoni, Compt. rend. Soc. Biol., Paris, 99, 1928, 312-314.

5. Tarpeia vitulae apec. nov. From Latin vitula, cow-calf.

Common name: Pneumoenteritis virus Hosts: BOVIDAE-Bostaurus L., domestic cattle. Experimentally, also MURIDAE-Mus musculus L., mouse. Geographical distribution: United

States. Induced disease: In cattle (calves). after incubation period of 2 to 4 days, fever increasing rapidly to 40 or 41° C and lasting 3 to 5 days; usually after first day of fever, diarrhea with feces soft, yellow, voluminous, fetid in odor, occasionally blood-tinged or fluid; diarrhea is followed by pneumonia and recovery after disappearance of fever; catarrhal enteritis and a bronchopne umonia usually confined to the anterior lobes of the lungs underlie the symptoms, no inclusion bodies in cells of affected tissues.

Transmission. By pen contacts with infected calves. Experimentally, by intranssal inoculation of calves, using mocula prepared from lungs of infected mice.

Serological relationships Recovered animals develop neutralizing antibodies.

Immunological relationships: A specific resistance to reinfection is conferred by an attack of the disease.

Filterability: Passes Berkefeld N filter. Literature: Baker, Cornell Vet., 32, 1942, 202-204; Jour. Exp. Med 78, 1943, 435-446.

6. Tarpeia canis spec. nov. From Latin cants, dog.

name: Canine-distemper Common virus.

Hosts: CANIDAE-Canis familiaria L., dog; Vulpes sp., fox. MUSTELI. DAE-ferret,

Insusceptible species: Man, rabbit, guinea pig, white rat, cat.

Geographical distribution: Widespread throughout the world.

Induced disease: In dog, after 4 days from time of infection, fever and a natery discharge from the eyes and nose, sometimes inconspicuous but often profuse; usually diarrhea and wasting followed by recovery or, exceptionally, death. Virus passes from the respiratory tract through the blood stream to its favored sites in vascular endothelium and cells of the reticulo-endothelial system. Nuclear inclusions are found in layer cells, bronchial epithelial cells, glandular cells of the stomach and intestine, and bile duct epithe. lial cells: there are also cytoplasmic inclusions in bile-duct epithelial cells.

Transmission: By contact. Probably by air-borne droplets. No arthropod

vector is recognized.

Immunological relationships: Deadvaccine treatment followed by livingvirus treatment produces a lasting immunity. Virus inactivated by photodynamic effect in 2 mm layer of 1:50,000 or 1:100,000 methylene blue, exposed 30 minutes at 20 cm from 100 candle power lamp, still immunizes. Vaccine may be dried.

Filterability · Passes Chamberland la and Mandler filters.

Other properties · Viable in liver tissue at 10° C for 35, not 85, days; in glycerinesaline solution at 10° C, 67 days though deteriorated, in vacuum-dried liver tissue, at 10° C, 90 days. If dried from frozen state, virus is viable in vacuum st least 430 days at 7° C, in oxygen-free nitrogen at least 365 days at 7°C. Viable in 25 per cent sterile horse serum at -21° C more than 693 days.

Literature Carre, Compt. rend. Acad. Sci., Paris, 140, 1905, 689-690; Dalldorf, Jour. Evp. Med., 70, 1933, 19-27, De Monbreun, Am. Jour. Path, 15, 1937, 167-212; Dunkin and Laidlaw, Jour. Comp. Path. and Therap., 93, 1926, 201-212, 213-221; Green and Evans., Am. Jour. Hyg., 29 (B), 1939, 73-87; Laidlaw and Dunkin, Jour. Comp. Path. and Therap., 95, 1936, 522-230, 44, 1928, 1-17, 297-227, Perdmu and Todd, ibid., 46, 1933, 78-83, Seedentopt and Green, Jour. Int Dis., 21, 1942, 233-239; Wherton and Wharton, Am. Jour. Hyg., 19, 1934, 189-216

7, Tarpeta vulpis spec, nor. I'mm Latin sulpes, fox.

Common name Fox-encephalitis virus Hosts CANIDAE-Vulpes sp., silver fox Experimentally, also some, but not all, dogs, cayote.

Insusceptible species Gray for, mink, ferret, sheep, laboratory rabbit.

Geographical distribution United

Induced disease. In fax, after 2 days from time of infection, kee of america. sheld nazal discharge; convulsions with early death or hyperexcuability, blind untking letharms . flacerd or spastic paralsas, muscular twitching, fearfulness, weakness, coma and death, many more foxes become infected in enizooties this show obvious disease, some bring symptomless carriers, 12 to 26 per cent fainh ties may be experienced among young foxes on rauches, 3 to 9 per cent among adults. Intranuclear inclusions in vascu for endothelial cells especially in cerebral endathelium, emetimes in Legatic cells and enduteled cells of liver and kidnes . to intraction amic inclusions, time in heart blood spicen, and brain, in carriers. tirus is believed to persist in focal lesions in upper respiratory tract. Experimen tally to susceptible does, sometimes coryza, discharge from eyes and nose often purulent, commonly fits of excite ment, coma, death, recovers rare, cellular infiltration in the central persons san. tem, local necrosis of the laver, specific

intranuclear inclusions in cells of the vascular endothelium, meningcal cells, reticulo-endothelium, hepatic cells, and occasionally in cortical cells of the adrenal.

Transmission. Experimentally, by akin searmeation, intransscular injection, incutation of crysterna, intratesticular injection, inoculation of crysterna, intratesticular injection, inoculation of masal cavity; not by corneal searmeation.

Immunological relationships: Injections of this virus afford no immunity to subsequent infection by canine distemper virus.

Filterability, Passes Berkefeld N filter. Other properties: Viable in 50 per cent glycerine for several years, in carenss for several days.

Literature Barton and Green, Am. Jour Hyg., 37, 1943, 21-36, Green, Proc. Soc. Exp. Bol. and Med., 25, 1920, 677-678, Am. Jour. Hyg., 15, 1931, 201-223; Green and Dewey, Proc. Soc. Exp. Biol., and Med., 27, 1929, 129-130; Green and Evace, Am. Jour. Hyg., 26 (B), 1932, 73-87, Green and Shillinger, 1964, 18, 1933, 402-491, 19, 1931, 363-375; 16, 1933, 402-481, 19, 1931, 313-301, 21, 1935, 205-388, 24, 1930, 67-70, Lucao, Am. Jour. Path. 16, 190, 733-700.

8 Tarpeta vivertae spec nor. From

Common name Ferret-distemper virus

Host WUSTELIDAE-Wustela furo, ferret

Insusceptible species Dog, mouse, rat, guines pig, rabbit,

Geographical distribution United States.

Induced disease. In ferret, fever to 185 or 190° F, lettargs, loss of appetite, conjunctivitis with exudate closing eyes, sometimes a purulant masal disefarget, weight loss small, energing rare, difficulty in breathing, death 14 to 56 days after inoculation (average 26 days), semetimes preceded by convulsions and other nervous signs; fatality rate 70 to 100 per cent.

Transmission: By cage contacts. By feeding. Experimentally by intranasal, subcutaneous, or intradermal inoculation.

Immunological relationships: In immunized animals, no cross immunity with canine distemper virus nor with human influenza virus,

Thermal inactivation: At 60° C in 30 minutes.

Filterability: Passes Berkefeld N filter. Other properties: Viable at least 3, but not 5, months in 50 per cent neutral glycerine; at least 4 months when frozen and dried in vacuo.

Literature: Slanetz and Smetana, Jour. Exp. Med., 66, 1937, 653-666; Spooner, Jour. Hyg., 38, 1938, 79-59.

9. Tarpela avium spec. nov. From Latin ares, fowl of the air.

Common names: Laryngotracheitis virus; also known as infectious laryngotracheitis virus and as infectious bronchitis virus.

Hosts: PHASIANIDAE—Gallus gallus (L.), chicken. Experimentally, also PHASIANIDAE—pheasant; Ft, hybrid between male Ringneck pheasant and female bantam chicken; choricaliantoic membrane of developing chicken embryo (with macroscopic lesions on membrane as a result of proliferative and necrotic changes); turkey embryo

Insusceptible species: Guinca fowl (no evidence of discase on inoculation); white rat, guinea pig, rabbit; embryos of pigeon, guinea fowl, and duck.

Geographical distribution United States, Canada, Australia.

noss of appears, man, both eyes, respiratory distress, hemorrhagic and nucous exudate in lumen of traebea and occasionally in the bronchi; death as a result of asphyxiation or, more often, recovery, recovered birds occasionally carry the virus in the upper respiratory tract for some time (a period of 467 days has been recorded); virus is not found on eggs during an outbreak in a flock, but is always in trachea of an affected bird; intraductear inclusions in trachea lesions; virus has special affinity for mucous membrane of eye, nostril, larynx, trachea, cloaca, and burss of Pabrielus; suvally affects more than half the birds in a flock, with a mortality of 5 to 60 per cent (averaging between 10 and 20 per cent).

Transmission: By contacts, Experimentally, by intrabursal injection (in bursa of Fabricius) or by rubbing the mucous membrane in the dorsal region of the outer or proctodeal part of the class with a small cotton swab moistened with a suspension of virus.

Serological relationships: Serum from recovered fowl neutralizes virus; dilution tends to reactivate neutralized virus.

Immunological relationships: Experimental infection of cloaca and burss of Fabricius, especially in 2 to 4-month-old birds, immunizes against infection by subsequent trached inoculation.

Thermal inactivation: At 55.5° C in 10 to 15 minutes; at 60° C in 2 to 3 minutes; at 75° C in ½ to ½ minute; all tests with virus in the presence of tracheal exudate.

Filterability: Passes Berkefeld V and N filters. Strains: A Victorian strain has been re-

ported as of low viruleuce for forfs.

Other properties: Fuertivated in 5 per cent phenol in 1 minute; in 3 per cent cresol compound in 4 minute; in 1 per cent sodium hydroxide in 4 minute. Visible in tracheal fluid in dark for 75, not 110, days; in light for 6, not 7, hours; in buffer solin at pH 7.4 for 131 days; at 4 to 10° C in dark for at least 217 days; in dried state for at least 611 days. Visible in dead body at 37° C for 22, not 44, hours; at 13 to 23° C for 10, not 15, days; at 4 to 10° C for 30, not 60, days.

t Literature: Bench, Science, 72, 1930, 633-634; Jour. Exp. Med., 54, 1931, 809-816; Jour. Inf. Dis., 57, 1935, 133-135;

52. Pseudomonas membranoformis (Zobell and Allen) Zobell. (Achromobacter membranoformis Zobell and Allen, Jour. Bact., 29, 1935, 246, Zobell, Jour Bact., 46, 1943, 45) From Latin membrana, membrane, and forma having the form of.

Rods: 0 9 to 1.2 by 3.5 to 48 microns, occurring singly and in pairs. Motile with lophotrichous flagella Encapsulated. Gram-negative

Gelatin stab: Growth filiform, best at top, with slow erateriform liquefaction Agar colonies: Circular, 1 0 to 2 5 mm.

with crinkled surface.

Agar slant: Moderate, beaded, raised growth. Membranous consistency Becomes browned with age.

Broth · Slight turbidity, flocculent sedsment, film of growth on walls of test tube

Milk: No growth.

Potato: No growth. Indole not formed.

Nitrites not produced from nitrates.

No H2S produced. Acid but not gas from glucose, sucroso,

devtrin and mannitol. No acid from lactose or xylose.

No diastatic action.

Optimum temperature 20° to 25°G. Aerobic.

Source: Sea water Habitat : Sea water.

marinoglutinosa 53. Pseudomonas (Zobell and Allen) Zobell. (Achromobacter marinoglutinosus Zobell and Allen, Jour, Bact . 29, 1935, 246; Zobell, Jour. Bact , 46, 1943, 45). From Latin marinus, pertaining to the sea, and glutinosus, full of glue, sticky

Short rods . 0.7 to 1.0 by 1.8 to 2.4 microns, with rounded ends, occurring singly, in pairs and in clumps. Motile with polar flagella Staining granular.

Pigment.

Agar colonies: Round with concentrie

circles and cripkled radial lines, 1.5 to 50 mm in diameter. No pigment. Agar slant. Moderate, filiform, flat

Broth: Moderate clouding, marked

ring, adberent film of growth on test tube wall, and flaky sediment.

Milk: No growth. Potato: No growth.

Butvrous consistency.

Indole not formed

Nitrites not produced from nitrates. Hydrogen sulfide and ammonia pro-

duced from Bacto-tryptone.

Acid but not gas from xylose and dextrin. No acid from glucose, lactose, sucrose and mannitol.

Starch is hydrolyzed.

Optimum temperature 20° to 25°C.

Aerobie, facultative Source. Sea water.

Habitat: Sea water.

54. Pseudomonas gelatica (Gran) Bergey et al (Bacillus gelaticus Gran. Bergens Museums Aarbog, 1902, 14; Bacterium gelaticum Lundestad, Cent. f. Bakt., II Abt., 78, 1923, 323; Bergey et al . Manual, 3rd ed , 1930, 175.) From French, like gelatin

Rods, with rounded ends, 0.6 to 1.2 by 1 2 to 26 microns, occurring singly, in noirs, and sometimes in sbort chains, Motile. Gram-negative.

Fish-gelatin colonies: Circular, transpercut, glistening, becoming brownish in

color. Fish gelatin stab : Liquetaction infundibuliform, with greenish color.

Sea-weed agar colonies. Circular, flat, entire, abstening, reddish-brown center with grayish-white periphery, Lique-

Fish-agar slant: Flat, transparent streak, with undulate margin, reddishbroun.

Broth, Turbid with flocculent pellicle. and greenish-yellow sediment,

Indole not formed.

Nitrites are produced from nitrates. Starch hydrolyzed.

in minced swine testicle on solid serumagar and on egg membrane, increase being limited to the living tissues from the swine and furnishing inoculum active in amounts as small as 10-2 ml.

Transmission: By feeding. Through air contamination. Rarely by contact. Experimentally, by subcutaneous injection. Urine highly infective. Virus in blood and all tissues early in disease.

Serological relationships: Immune serum affords passive protection.

Thermal inactivation: At 55° C in 30 minutes; at 60° C in 10 minutes. At 72° C in 1 hour in dried blood.

Filterability: Passes Berkefeld filter. Other properties: Viable in blood in cool, dark place at least 6 years.

Literature. De Kock et al., Onderstepoort Jour. Vet. Sci. and Anim. Indust., 14, 1910, 31-93; Hecke, Cont. f. Bakt., I Abt., Orig., 199, 1932, 517-529; Montgomery, Jour. Comp. Path. and Therap. 34, 1921, 159-191; Röhrer, Arch. Tierheitk., 62, 1930, 345-372, 439-462; 64, 1931, 124-143, TenBrocck, Jour. Evp. Med., 74, 1941, 427-432.

2. Tortor bovis spec. nov. From Latin bos, cow.

Common names Cattle-plague virus, virus of pestis bovina, runderpest virus, Rinderpest virus,

Hosts · BOVIDAE—Bos taurus L., domestic cattle; swine, buffalo, zebu cattle, sheep, goat, camel, deer. Koedoe, eland, bushbuck, duiker, and other antelopes.

Insusceptible species Man, solipeds, carnivora.

Geographical distribution. Widespread over Asia and the Asiatic islands. At times in Western Europe. Enzostically in Turkey. Periodically in North Africa. Rot in Egypt; at times throughout Africa. Not in North America. At times in South America, Australia (suppressed quickly).

Induced disease. In domestic cattle, after 3 to 9 days, febrile reaction, restlessness, loss of appetite, cessation of rumina-

tion; fever highest at 5th or 6th day of disease, then temperature drops to normal or aubnormal and diarrhea begins; muzzle dry, coat staring, hair dull, skin moist in parts; twitching of superficial muscles, grinding of teeth, arching of back, glairy discharge from nose, redness of mucous membranes; restlessness increases, durrhea becomes severe with fetid, bloodstained or blackish liquid discharges; weakness, drooping of ears, occasional yawning, coldness of extremities; occasionally excitement precedes weakness: skin may become red and moist, showing protuberances and vesicles, with matted hair; later wrinkling and scab formation; conjunctiva red, eyelids awollen, tears flowing, followed by mucous, then purulent, discharge; sometimes a cough develops and respirations become mpid; red spots inside mouth develop into erosions or ulcers, often confluent; pregnant animals often abort; milk of cows decreases, sometimes becoming yellow and watery. Death is sometimes early (1 to 2 days after first manifestations of discase), more often delayed (4 to 7 days); sometimes animals live 2 or 3 weeks or longer. Disease milder and more chronic where enzoatic; morbidity to 100 per cent and mortality to 96 per cent in new areas. Recovered animals show a lasting, sterile mmunity. Urine, feces, nasal and lachcymal discharges, sweat, aqueous humour, cerebrospinal fluid, lymph, emulsions of viscera and muscles, and blood are infective during the course of the disease;

Transmission. By contact, even during prodromal period; by contaminated food, troughs, or other articles. No insect vector is known.

Immunological relationships. One attack confers a lasting immunity, except arely, when a mild second attack may occur. A calf from a diseased mother may be resistant if pregnancy was far advanced when the disease occurred.

Filterability: Passes Berkefeld V filter candle, with difficulty.

Other properties: Remains infective at

Beach et al., Poultry Science, 15, 1934, 918-209; Beaudette and Hudson, Science, 76, 1932, 23; Jour. Am. Vet. Med. Assoc., 82 (N.S. 35), 1933, Am. Vet. Med. Assoc., 82 (N.S. 45), 1934, 64, 88 (N.S. 47), 1936, 597-699; Jour. Inf. Dia., 57, 1933, 201-206; Brandly, and Bushmell, Poultry Science, 15, 1934, 212-217; Burnet, Brit. Jour. Exp. Path., 15, 1931, 32-55, Jour. Exp. Austral Jour. Exp. Bil., 364, 67, 1804, 68, 1936, 687-701; Burnet and Foley, Austral Jour. Exp. Bil. and Med. Sec., 19, 1911, 235-210, Gibbs, Jour. Am. Vet Med. Assoc., 81, (N.S. 54), 1932, 631-651, Masschusetts Agr. Exp. Sta., 1932, 631-651, Masschusetts Agr. Exp. Sta.

Bull. 295, 1933, bidd., Bull. 511, 1931; Hinshaw et al., Poultry Science, 10, 1931, 375-332; Hadson and Beaudette, Science, 76, 1932, 31; Cornell Vet., 22, 1932, 70-74; Kernohan, California Agr. Exp. Sta., Bull. 494, 1930, 3-22; Jour. Am. Vet. Med., Assoc., 73 (N. S. 31), 1931, 553-555; Komarov and Beaudette, Poultry Science, 11, 1932, 335-333; May and Tittsler, Jour. Am Vet. Med. Assoc., 67, (N. S 20), 1925, 221-231, Schalm and Beach, Jour. Inf. Dis., 68, 1935, 210-223; Scifried, Jour. Exp. Med., 44, 1931, 817-850.

### Genus III. Tortor gen. nov.

Viruses of the Hog-Cholera Group inducing diseases characterized by involvement of many tissues. Generic name from Latin tortor, termenter.

The type species is Tortor suis spec. nov.

#### Key to the species of genus Tortor.

- I in mammals.
  - A. Infecting swine.
  - B Infecting cattle.
  - C Infecting the horse.
  - D Infecting sheep
  - E. Infecting est
- II In birds
- tt m otteta

carmer).

- 1. Torios se s
- 2. Tortor bous.
- 3. Tarlet cauerum
- 4. Tortor cous.
- 5. Tertor oria.
- 6. Tortor felis
- 7. Tertor galls.
- 8. Tortor Jurens

i. Tortor suis apec. nor. From Latin aus, hog. Common names Hog-cholera arus,

snane fever virus

Host SUIDAE—Sus scrofa I., domestic snane Wartley (symptomless

Insusceptible species. Dog. cat. cow. horse, donkey, sheep, gost, rabbit, guines pig, mouse, rat, goose, ben, duck, pigron. Geographical distribution. Minest universal in pig breeding countries, espe

easily sn Europe, the British Isles, North and South America.

Induced disease In some, after intramuscular injection, increased temperature and prestration within 23 to 3 days; later lymph nodes calarged, sometimes hemorrhage, benorrhages under capsule of kidneys. Virus may remain in blood of eccoseded pags for 10 months. Acquired immunity is lasting, but most naturally infected animals die in newly infected beris. Virus has been cultured

Literature: Alexander, Onderstepoort Jour. Vet. Sci. and Anim. Indust., 4. 1935, 291-322, 323-348, 349-377, 379-388; 7, 1936, 11-16; 11, 1938, 9-19; Alexander and DuToit, ibid., 2, 1934, 375-391; Alexander and Mason, ibid., 16, 1911, 19-32; Alexander et al., ibid., 7, 1936, 17-30; DuToit et al., ibid., 1, 1933, 21-21, 25-50; Henning, in Animal Diseases in South Africa, Central News Agency, Limited, South Africa. 2, 1932, 516-538; M'Fadyean, Jour. Comp. Path. and Therap., 13, 1900, 1-20; 23, 1910, 27-33. 325-328; Nieschulz and DuToit, Onderstepoort Jour. Vet. Med. and Anim. Indust., 8, 1937, 213-268; Polson, ibid., 16, 1941, 33-50, 51-66; Nature, 148, 1911, 593-591; Theiler, Doutsch, tierarztl. Woehenschr., 9, 1901, 201-203, 221-226, 233-237, 211-212; Report for 1905-1906 of the Govt. Veterinary Bacteriologist, Transvaal Dept. Agr., 1907, 160-162; Jour, Comp. Path, and Therap., 23, 1910. 315-325.

4. Tortor equae spec. nov. From Latin equa, mare.

Common name . Mare abortion virus.

Hosts: EQUIDAE—Equus caballus

L., horse. Experimentally, also Syrian hamster (newborn); tissues of human placenta grafted on the choroaliantois of the chick embryo.

Insusceptible species: Chieken (embryo; no observed susceptibility).

Induced disease. In horse, small, multiple, graysts white areas of necrosis in the livers of aborted fetuses, acidophile intranuclear inclusions in hepatic cells around these foci, in epithelial cells of bile duets, and in bronchial epithelium, petechial hemorrhages in the heart, spleen, and lungs; excess fluid in the thoracic cavity.

Transmission: By contact. By living on contaminated stalls.

Literature: Anderson and Goodpasture, Am. Jour. Path, 18, 1942, 555-561; Dimock, Jour. Am. Vet. Med. Assoc., 96, 1940, 665-666; Dimock and Edwards, Cornell Vet., 26, 1936, 231-240; Goodpasture and Anderson, Am. Jour. Path., 18, 1942, 563-575; Hupbauer, Münch. Tier-ärztl. Wchnschr., 89, 1933, 37-38; Miessner and Harms, Deutsche Tierärzil. Wchnschr., 49, 1933, 745-748.

5. Testor evis spec. nov. From Latin ovis, sheep. Common name: Blue-tongue virus

Hosts: BOVIDAE—Ovis aries L., aheep; Bos taurus L., cattle.
Geographical distribution: South Mica.

Induced disease : Both sheep and cattle may carry the virus at times without Obvious manifestations of disease or there may be severe manifestations. In sheep. experimentally, diffuse hyperemia of buccal mucosa, especially of lips; then petechiae and ecchymoses followed by excoriations and necrosis of the mucous membrane, especially on lips, tongue, inside of cheeks, dental pad, gums, murzle, and external nares; sometimes deep scated necrotic ulcers on tangue developing from the more usual superficial necrotic process; muceld discharge from nostrile, becoming muco-hemorrhagie; commonly frothing at the mouth in early stages of the disease; frequently reddening of akin of lips and nose; rarely whole skin becomes flushed and wool is shed; often awalling of vulva with necrotic changes on borders and petechiae in mucosa; tongue sometimes awollen; lameness common and severe; recovery or 'ba death. In cattle, edema of lips and tongue; hyperemia of oral mucosa; multiple hemorrhages in skin, lips, mucous membrane of the lips, tongue, dental pad, buccal cavity, small intestine, myocardium, epicardium, and endocardium, less frequently in the traches, nasal cavity, bladder, urethra, pulmonary artery, and pleura, localized necrotic areas followed by electation on lips, gums, the dental pad, tongue, mucous membrane of the rumen, pylorus of the stomach, and the external nares; scattered skin lesions with reddening, slight exudation, crusting, sloughing of crusts and hair together,

least 2 weeks at 0° C in virulent blood, less than 2 days in hides dired in direct sunlight, 3 days in contaminated wool, as long as 12 days in mest 7 is inactivated by glycerine, blic, chloroform, formalin, and 2 per cent plucol, is virulent at least 25 days in body of feech, Hrund boguttow Whatton (HIRUDIDAE), led on such animal.

Literature: Boynton, Philippine Agr. Rev., 10, 1917, 110-133, Daubney, Jour. Comp Path and Therap, 4f, 1928, 228-218, 223-297, Horaby, ibrd, 4f, 1928, 17-21; Pfaff, Onderstepoort Jour Vet. Sci and Anim Indust., 11, 1938, 265-330; 46, 1910, 175-181; Weston, Jour Am Vet. Med. Assoc. 6f (N.S. 19) 1921, 337-330.

# 3 Tortor equorum spec. nov From

Common names Horse-sickness virus, African horse sickness virus, virus of pestis equorum, virus of perdesiekte, virus of South African Pferdesterbe,

Hosts EQUIDAE—Equis cobolius L, horre, perhaps II catinus L, donke, perhaps II catinus L, donke; Experimentally, also CAVIDAE—Comporetilly (1), gaurae pix MCRIDAE—Ratius noruegicus (Gridelen), wild and albino 1st, mouve, Angura gari, Mustamya coucha, multimammate mouse, Tatera lobengula, genline, chiek mehryo (but no virus in hateleed chiek). Mule and zelm relatively resistant

Insuscriptible species HOMINIDAE

- Homo suprem b., man. LEPORI
DAE— (tryctolagus cantealus (L.), rabist
two observed disease)

Geographical distribution. Misca, especually to constal regions and treer valleys.

Induced disease. In the bone, four types of disease are recognized. Horse-species ever, produmin period 5 to 25 days, the of body temperature to 102° F and temperatures in another day or two, sometimes less of appetite, reduces of conjunctiva fation disease, and the originative attention, and we

celerated pulse; recovery prompt. Dunkop or acute pulmonary horse-sickness, prodramal period of 3 to 5 days, severe dyspaes, fever, coughing, frothing at postrils, fever to 106° F, breathing rate to 60 a minute, nostrils diluted, head and neck extended, cars drooming, sweating, progressive weakness; often fatal. Dikkop, or cardiac form of borse-sickness. prodromal period 5 to 21 days, fever develops slowly, lasts long; edematous swellings of head and neck, symptoms of cardiae dyspnea, sometimes blood spots on conjunctiva, mucous membranes of mouth and toneue bluish, restlessness; sometimes fatal outcome. Mixed form of horse-sickness, combining features of pulmonary and cardiac types. Horses recovering from natural infections are know mas "solted" and possess heightened remistance to the disease.

Transmission Not by contact. Mosquitoes and biting flies have been suspected as vectors. Experimentally, by mirrarenous or subcutaneous infection.

Serological relationships Serologically distinguishable strains exist.

Immunological relationships Immunity to homologous strain complete after an attack (horse then known as "kalted" for that strain), but Immunity to betterlogous strains incomplete. Antilodice absent from young at birth but as high in titer as in dim within 30 hours, presumvibly from colostral milk; declining graduulty over a period of about 6 months.

Thermal mactivation - At 57.5 to 60° C in 10 minutes.

Filternheity Passes Berkefeld, Chamterland F, and Seitz EK filters.

Other properties Vivile dry at least 15 months Stable in alkaline solutions (to pH 10), unstable in acid theyond pH 60). Serum salme solutions preferable to salme solutions for storage. Particle deameter determined as 40 to 00 millimicross funca 50 millimicrons by thiration methods. 53 millimicrons by cen-

trifuging Density 1.25 gm per ml.

Implector paint at pli 1 %.

and seek shade, drooping of wings and tail; eyes closed or partly closed; some dyspace; in some cases, edema of head and neck; in late stages, sometimes eyanosis of comb and skin; staggering, twitching, or spasms; faver may disappear and temperature become authoromal before death; recovery in about 30 per cent of all cases; linear and punctiform hemorrhages throughout body.

Transmission: Method of natural transmission unknown. The fowl louse, Goniotes dissimilis (PHILOPTERIDAE), has been suspected as vector (Maggiora and Tombolato, Rendiconti, Accademia delle Science dell'Instituto di Bolegna, n.s. 27, 1923, 200-203). Experimentally, by subcutaneous, intramuscular, and intravenous iniection.

Scrological relationships: Specific neutralizing antiscream does not react with influenza virus. No reaction of fontplague virus with antiscra specific for canine distempor; influenza, or Rift Valley fever viruses.

Thermal inactivation: At 55° C in I hour in whole blood or brain.

Filterability Passes membrane of average pore diameter 150, not 100, not ordinarily 125, millunicrons. Passes Berkefeld and Chamberland filters

Other proporties: Particle diameter estimated by filtration as 60 to 90 millimicrons; by centrifugation, as 120 to 130 millimicrons. Viable after exposure in 1:10,000 dilution for 10 minutes, in 2 mm layer of 1:50,000 methylene blue, 15 cm from a 300 candle-power filament lamp Withstands drying. Precipitates from salt-free solutions or in presence of half-saturated ammonium sulphate solutions; virus held to be of globulin nature by Mrowka, Cent. f. Bakt., 1 Abt., Orig., 67, 1912, 243–250.

Strains Variant strains have been produced by intracerebral passage in brains of canaries and mice.

Literature Bechhold and Schlesinger, Biochem. Ztschr , 238, 1931, 337-414; Ztschr. Hyg. Infektionskr., 112, 1931, 668-679; Burnet and Ferry, Brit. Jour. Exp. Path., 18, 1934, 56-64; Centani, Cent. f. Bakt., I Abt., Orig., 31, 1902, 145-152, 182-201; Elford and Todd, Brit. Jour. Exp. Path., 14, 1933, 240-246; Findlay and Mackenzie, 1bid., 18, 1937, 146-155, 258-264; Findlay et al., Jour. Path. and Bact., 45, 1937, 589-596; Lépine Compt. rend. Soc. Biol., Paris, 191, 1936, 509-510; Mackenzie and Findlay, Brit. Jour. Exp. Path., 18, 1937, 138-145, Orig., 181, 1934, 1-6; Plotz and Haber, Compt. rend. Soc. Biol., Paris, 125, 1937, 339-340.

8. Tortor furens spec. nov. From Intin furere, to rage.

Common name: Newcastle-disease virus.

Hosts: PHASIANIDAE—Gallus gallus (L.), domestic chicken. HOMINI-DAE—Homo sapiens L., maa (by laboratory accident). Experimentally, also pigeon; chick embryo (with primary leasons and cytoplasmic (inclusions in choricallantoic membrane).

Geographical distribution England, probably also East Indies, Korea, Japan,

India, Australia.
Induced disease: In chicken, seule, febrile, highly contagious, usually fatal disease resembling fowl plague, loss of appetite, crouching artitude, half elseed eyes, rapid respirations, wakary yellowish white diarrhea with nat; rating dour ideath usually between 6th and 8th day. In man, accidentally infected in laboratory by virus sprayed info eye, virus recoverable from tempotarily inflamed eye, recovery in 8 days with gradual increase of specific antibodicalm blood.

Transmission: By contact between healthy and diseased birds.

Serological relationships Antiserum effective in neutralizing homologous

Immunological relationships: Chickens immune to infection by fowl-plague virus are susceptible to infection by this virus mucoid or mucopurulent discharge from nostrils; prognosis favorable in mild cases, but disease occasionally terminates with death.

Transmission: Not by contact: arthropod vector suspected.

Other properties: Infective particle calculated to be 87 to 105 millimicrons in diameter by sedimentation studies, 100 to 132 millimicrons in diameter by ultrafiltration.

Literature: Bekker et al., Onderstepoort Jour. Vet. Sci. and Anim. Indust . 2, 1934, 393-507; De Kock et al., abid , 8, 1937, 129-180; Henning, in Henning, M. W., Animal Diseases in South Africa, Central News Agency, Ltd., South Africa, 1932, vol. 2, chapter 27, pages 503-515; Mason and Neitz, Onderstepoort Jour. Vet. Sci. and Anim. Indust , 15, 1940, 149-157: Nieschulz ot al , toid , £, 1934, 500-562; Polson, Nature, 148, 1941. 593-594.

6. Tortor felis epec, nov. From Latin feles, cat.

Common names. Panieucopenia virus, infectious felice agranulocy tosis virus, infectious aled ocytosis virus, fcline enteritis virt.

Host: FCLIDAF-Felis catus L , do-

mestic caf

Insuscellabi species White mouse, guines pit, comestic rabbit, ferret, Citellus randsones (Sabine), ground equirrel.

Geographical distribution Umied

States, Germany Induced disease In cat, variable eflects, some Bidividuals little affected. others listless, recumbent, refusing food, showing some vomiting, diarries, masal and ocular declarges, aften death, after a few minutes of fibrillary twitching and terminal clonic convulsions, before there is much loss of weight, sometimes recor ery with return of appetite Profound lewopens and marked relative is mphoeytrau without thrombopeurs or appreci alle atema; proliferation of reticulotakthelal tells of lymph nodes and

spleen; intranuclear inclusion in cells of gastro-intestinal mucosa, spleen, lymph nodes, bone marrow, and bronchial mucosa.

Transmission: Perhaps by nasal droplets or contaminated food. No arthropod vector recognized. Experimentally by oral, intragastric, cutancous, subcutaneous, intraperitoncal, intravenous, and intranasal routes.

Serological relationships; Sers from nanleucopema-immune cats protects against agranulocytosis virus.

Immunological relationships; Cats immune as a result of earlier infection with agranulocytosis virus resist later inoculation with panleucopenia virus. Previous moculation meffective if made with hore cholera virus or fox-encephalitis virus.

Filterability, Passes Berkefeld V. N. and W filters and Seitz EK discs.

Other properties: Remains active in 50 per cent glycerine at least 138 days in tissues; not inactivated by drying while frozen, nor by freezing at about -80° C.

Literature : Hammon and Enders, Jour, Exp. Med., 69, 1939, 327-352; 70, 1939. 557-561; Kikuth et al., Cent. f. Bakt., I Abt . Orig . 148. 1940. 1-17: Lawrence and Syverton, Proc. Soc Evp. Biol. and Med . 53, 1938, 914-918, Lawrence et al., Jour. Exp. Med., 77, 1913, 57-64; Am. Jour. Path., 10, 1940, 333-351; Syverton et al . Jour. Exp Med., 77, 1913, 41-56.

7 Tortor galli spec. nor. From Latin oallus, cock.

Common names. Fowl-plague virus. fon l-pest virus.

Hosta Chiefly chicken, turkey, goose, L'apermentally, also ferret, rhesus mon-Lev. hedgehog, pigeon, duck, canary, mouse, rat, rabbit. Multiplies in embryonsted ben's egg, edema, but no discrete primary lesions in choricallantoic membrane.

Geographical distribution: Widespread throughout Europe, North and South America, Aria.

Induced disease: In chicken, loss of appetite, tendency to leave companions

# FAMILY V. TRIFURACEAE FAM. NOV.

Viruses of the Infectious Anemia Group, inducing diseases mainly characterized by disturbances in balance of blood cells. There is a single genus.

# Genus Trifur gen. nor.

With characters of the family. Generic name from Latin trifur, arrant thief. The type species is Trifur equorum spec. nov.

Key to the species of genus Trifur.

- I Affecting horse.
- II. Affecting fowl.
- 1. Trifur equorum spec. nov. From Latin equus, horse,

Common name: Equine infectiousanemia virus

Hosts: EQUIDAE-Equus caballus L., horse; E. asinus L., donkey. HO-MINIDAE-Homo sapiens L., man. Experimentally, also EQUIDAE-Equus asinus X E. caballus, mule, SUIDAE -Sus scrofa L., swine.

Insusceptable species: BOVIDAE-Bos taurus L , cattle; Ovis aries L., sheep; Capra hircus L., goat. CANI-DAB-Canis familiaris L., dog.

Geographical distribution: Europe, Union of South Africa, United States, Canada, Japan; at times in most parts of the world: not Australia.

Induced disease In horse, progressive anemia with eventual death or chaical recovery and retention of virus; disease may be scute, subscute, or chronic; in acute disease, temperature rise to 104 to 105° F. or even 106 to 107° F. remaining high much of the time until death or change to subscute or chronic form; in the acute form of the disease there is dullness, decreased appetite, drooping of head, flexing of limb not supporting weight; sometimes increase in pulse frequency to 70 or even 100 a minute but oftener rates around 50 a minute; conjunctiva sometimes colored orange, with injection of vessels and petechine, later becoming muddy colored or pale red, membrane edematous; uncertain gait.

1. Trifur equorum.

2. Trifur gallinarum.

trailing of hind feet, prostration, sometimes death; subacute disease milder and with remissions; chronic disease still milder, anemia conspicuous, sometimes death from debility or at end of a febrile attack; blood infective long (3 to 7 years) after clinical recovery; urine infective to horse by mouth. In man, diarrhea alternating with constipation, herpes-like exanthema on abdominal wall, blood sometimes in feces; persistent headache, temperature normal; later, lumbar pains, generalized edema, general debility, loss of flesh, pallor of face and mucosae; filtered blood in 1 ml, amount fatal to horse, inducing infectious anemia; improvement after 2 to 4 years. In swine, experimentally, sometimes no outward and obvious signs of disease but blood abnormal and infective : sometimes severe anemia, fever, prostration, loss of appetite.

Thermal inactivation: At 58 to 60° C

in I hour. Filterability: Passes Berkefeld V filter candle.

Other properties: Viable in blood in citrate saline at -2° C for at least a year. Drying does not inactivate in 10 days but does in 1 month.

Literature: DeKock, Union of South Africa, Dept. of Agr., 9th and 10th Reports for 1923, Pretoria 1924, 253-313; Habersang, Monatshefte für prakt. Tierheilk., 20, 1920, 171-176; Kutsche, ibid., 30, 1920, 557-568; Peters, Jour. Am. Vet.

and sice rersa. Immunization to this virus does not decrease susceptibility to combor mouth form of few! pox.

Thermal inactivation: At 60° C in I hour; not at 50° C in 30 minutes. Filterability: Passes Berkefeld, Cham-

berland Li, and Seitz filters.
Other properties: Particle diameter

calculated from filtration experiments to

be 80 to 120 millimierons. Not inactivated in 30 minutes in 1:50,000 methylene blue solution in 2 mm layer 15 cm from a 200 candle-power filament lamp.

Literature: Burnet, Med. Jour. Australia, 30, 1943, 313-314; Burnet and Ferry, Brit. Jour. Exp. Path., 16, 1934, 56-64; Doyle, Jour. Comp. Path. and Themp., 40, 1927, 144-169.

# FAMILY VI. RABULACEAE FAM, NOV.

Viruses of the Mumps Group, characterized in general by a special affinity for tissues of the salivary glands. There is a single genus,

# Genus I. Rabula gen. nov.

With characters of the family. Generic name from Latin rabula, pettilogger. The type species is Rabula inflans spec. now.

# Key to species of the cenus Rabula.

- I. Affecting man.
- II. Affecting guinea pig.
- III. Affecting hamster.
- IV. Affecting rat.
- V. Affecting mouse.

- Rabula inflans.
- Rabula levis.
- 3. Rabula innocuus.
- 4. Rabula exiguus.
- 5. Rabula latens.

1. Rabula inflans spec. nov. From Latin enflare, to puff up.

Common names. Mumps virus, virus of epidemic parotitis.

p.

Musikanis, .... -Felis catus L., domestic cat.

Geographical distribution: World-wide.

Induced disease: In man, in order of frequency, parotitis, orchitis, meningoencephalitis, pancreatitis, or nyaritis; rarely fatal, when parotitis occurs, onset in 'n aman both montid

ture; cytoplasmic inclusion bodies affected glands, staining pink, round or oval, 3 to 10 microns in diameter, often vacuolate, usually surrounded by a narrow clear zone in the cytoplasm; blood and uninoculated salivary gland of affected animal not effective sources of virus.

Transmission: Probably by droplets arising directly from infected individuals. Experimentally, by injecting sterile fluids containing virus into Stenson's duct of parotid gland in Macaca mulatta. Serological relationships: A specific complement-fixing antibody occurs in human and monkey convalescent serum and is demonstrable by the use of mon-

kev-gland antigen. Immunological relationships: Specific immunity induced by attack; passive immunization rarely successful.

Thermal inactivation: At 55° C in 1 hour.

Filterability: Passes Berkefeld V and N filter candles.

Other properties: Viable in 50 per cent glycerine at 2° C at least 5 weeks, in 50 per cent glycerine at 10° C. at least 7 weeks, dried while frozen at least 7 weeks,

in frozen saliva at least 3 weeks.

swelling and malause gradually disappearing within a week or 10 days; there is virus in salıva 48 hours after onset; orchitis, less common, is usually unilateral and may be accompanied by some epididymitis. In rhesus monkey, experimentally, acute, non-suppurative parotitis; focal necrosis in acinar epithelial cells of parotid gland, and secondary inflammation; dissemination of lesions within the gland, enlargement of gland to palpation and pitting edema of jowl 6 to 8 days after moculation, often with a rise of temperaMed. Assoc., 66, 1924, 363-366; Tbeiler and Kehoe, Union of South Africa, Dept. of Agr., 3rd and 4th Reports of the Director of Veterinary Research, 1915, 215-289.

2, Trifur gailluarum spec. nov. From Latin gallina, ben.

Common name: Fowl-leucosis virus.

Host Gallus gallus (L.), chicken.

Geographical distribution. United

States, England, Europe.
Induced disease In chicken, neuro-

lymphomatosis, with eye lesions (slate gray or blusb color replacing normal bay color of iris), anemia, hemocytoblastosis, lymphoid, crythroid or mycloid types of leucosis: the hemocytoblastosis is follawed by infiltration of the central peryous system, peripheral nerves, tris, and many visceral organs by hemocytoblasts and lymphocytes, producing lesions sometimes resembling neoplasms and consisting chiefly of hemocytoblasts (hemocytoblastomata); marrow of radius and ulna becomes hyperplastic; virus in blood plasma, blood cells, emulsions of organs; blood normal in its hydrogen-ion concentration; recovery never complete, some stocks less susceptible than others.

Transmission. By pen contact or contaminated litter. Experienceatly by intravenous injection of cell-free filtrates. Not by the mosquitoes, Culex prices and Atles acqupit (CULCIDAD). Dayold chicks from iritis parents contain the infective agent and show some form of the induced discuse in 80 per cent of the progeny if both parents show iritis, in 70 per cent if male is normal, 15 per cent y female is normal. Serological relationships: Specific neutralizing antibodies are formed in the rabbit as a result of injecting infective materials partly purified by sedimentation in the ultracentrifuse.

Thermal inactivation. At 56° C in 30 minutes.

Filterability: Passes Berkefeld V, N, and W filter candles; 1.5 per cent, but not often 3 per cent, colledion membranes; Scitz asbestos filter.

Other properties: Vable after drying at least 54 days, in glycerine at least 104 days, at -60° Cat least 6 months; after freering and thawing, and offer freering in Jupid of. Not viable after 14 days at 37.5° C. Particle downeter between 100 and 400 millimicrons.

Literature: Ellermann and Bang, Cent. f. Bakt., I Abt., Orig., 48, 1909, 4-5, 595-609, Furth, Proc. Soc. Exp. Biol. and Med., 27, 1929, 155-157; Jour, Exp. Med., 55, 1931, 243-267; 65, 1932, 465-478, 495-501; 58, 1933, 253-275; 69, 1931, 501-517; Furth and Miller, ibid., 55, 1932, 479-493; Hall et al., Am Jour. Vet. Res., 2, 1941, 272-279; Jármai, Arch. nissensch. u. prakt. Tserhielk., 62, 1930, 113-131; Johnson, Virginia Agr. Exp. Sta. Tech. Bull, 88, 1934, 1-32; Johnson and Bell, Jour. Inf Dis., 58, 1930, 342-318; Kabat and Furth, Jour. Exp. Med., 71, 1910. 55-70; 74, 1941, 257-261, Lee and Wilcke. Am. Jour. Vct. Res., \$, 1911, 292-294; Lee et al , Jour Infect. Dis., 61, 1937. 1-20. Pierce, Am. Jour. Path., 18, 1912. 1127-1139, Ratcliffe and Stubbs, Jour. Inf. Dis., 66, 1935, 301-301.

No action on sugars.

Anaerohie, facultative.

Optimum temperature 20 to 25°C. Hahitat: Sea water of Norwegian coast.

55. Pseudomonas calcls (Drew) Kellerman and Smith. (Bacterium calcis Drew, Yearbook Carnegie Inst. Wash., 11, 1912, 136-144; Kellerman and Smith, Proc. Nat. Acad. Sci., 4, 1914, 400) From Latin calz (calc.), lime.

Ovoid rods, 1.1 by 1.5 to 3 microns, usually single hut may form long chains. Actively motile with one polar flagellum.

Gram-negative.

Grows hest in sea water or 3 per cent salt media. Deposits CaCO<sub>4</sub>.

Agar colonies: Circular, with finely irregular outline, granular nppearance, clevated, epreading; old colonies having brownish tinge in center.

Gelatin stab: Infundibuliform lique-

faction.

Gelatin colonies Small, with liquefaction.

Broth: Good growth especially in presence of potassium nitrate, peptone or calcium malate.

calcium malate.

Acid from glucose, mannite and sucrose but not from lactose.

Nitrates reduced to nitrites and ammonia.

Aerobic, facultative.

Optimum temperature 20 to 28°C. Hahitat: Sea water and marine mud.

Bavendamm (Arch 1. Mikrobiol., 3, 1932, 214) states that Pseudomonas calcis is probably synonymous with Bacterium brandtı, Bacterium bauri and Bacterium feitelt described by Parlandt (Bull. Jard imp. Bot. St. Petershurg, 11, 1911, 97-105).

 Sesudomonas calciprecipitans Molisch. (Cent. f. Bakt., II Aht., 65, 1925.
 From Latin, calx (calc.), lime; praccipilo, to cast down headlong, to precipitate.

Thin rods: 0.5 to 0.8 by 1.5 to 3.6 microns, with rounded ends, often staining irregularly. Motile, with one polar flagellum. Gram-negative.

Gelatin colonies: Circular, light brown in color (large colonies show CaCO: crystals).

Gelatin stab: Surface growth with filiform growth in depth. Liquefaction starts at bottom.

Agar colonies (sea water). Grayishwhite, glistening. In two to three weeks crystals of calcium carbonate form in the agar.

Agar slant: Slight, whitish, surface growth, becoming thick, spreading, glistening, with ahundant CaCO<sub>4</sub> crystals in medium.

Ammonia formed.
Aerohic, facultative.

Optimum temperature 20°C. Habitat : Sca water.

57. Pseudomonss Ichthyodermis (Wells Zobell) Zohell and Upham. (Achromobacter ichthyodermis Wells and Zohell, Proc. Nat. Acad. Sci., 20, 123, 1934; Zobell and Upham, Bull. Scripps Inst. Oceanography, 5, 1944, 246 and 253.) From Greek, ichthys, a fish; derma, skin.

Small rods, 0.9 to 13 by 3 to 5 microns, occurring singly and in pairs. No spores. Encapsulated. Polar flagella. Pleomorphic forms predominate in old cultures. Gram-negative.

Requires sea water following initial isolation. The following differential media are prepared with sea water.

Agar colonics: Glistening, colorless, convex, circular colonies 2 to 4 nm. in diameter.

Agar slants: Abundant, filiform, raised, smooth, opalescent growth.

Gelatin tube: Rapid crateriform liquefaction complete in 5 days at 18°C.

Sea water broth: Turbidity, with pellicle, little granular sediment and no odor-Milk: No growth. Casein digested

when 3 per cent salt is added.

Potato: No growth unless dialyzed in sea water. Then fair growth with no pigment.

Literature: Bloch, Am. Jour. Path., 15, 1937, 939-944; Enders and Cohen. Proc. Soc. Exp. Biol. and Med., 50, 1912. 180-184, Findlay and Clarke, Brit. Jour. Exp. Path., 15, 1931, 309-313; Johnson and Goodpasture, Jour. Exp. Med . 59. 1931, 1-19; Am. Jour. Hyg., 21, 1935, 46-57; 25, 1936, 329-339; Am. Jour. Path . 12, 1936, 495-510.

2. Rabula levis spec. nor. From Latin leris, trifling.

Common name Guinea-pag salivarycland virus.

Host. CAVIIDAE-Carra porcellus (L ), guinea pig (only known host; fetus more susceptible than post-ratal aninul. even if from immune mother).

Insuscentible species Rabbit, rat, cal. chicken, pigeon, dog, mouse, monkey (Macacus thesus)

distribution. United Geographical States, England.

Induced disease. In guinea pig, submaxiliary glands show swotten epithelial cells containing relatively dense acidophilic inclusions of granular material withmenlarged nucles, especially in ducts of the serous portion of the gland, and larger but fewer intracytoplasmic inclusigns, experimentally, by intracerebral injection of young guinea pig, prodromal period of about 2 days, then elevation of temperature to 105 or 106 F , a day later. bair raised, animal quiet , subsequently , stritability with tremors and slight con vulsive nervenesis, by fifth day, usually prestration, jerking newements, and en sung death, brain shows no gross fesions but exudite over surface, in meningeral exudate, many cells each containing an acadoplalic mass within its nucleus, by subcutaneous injectant, t trus recuterable after 2 neeks from submarillary glands. reryical lymph nodes, kidney, and lung. not from blood, haver, or spicen

Transmission Experimentally, by in oculation of submanifary gland or by intracerdical or subsultaments injection of materials from infected glands, with

difficulty from brain to brain. Pilocarnine stimulation increases numbers of inclusions.

Serological relationships . Specific neutralizing antibody is found in blood serum of ammals that are carrying virus in their

submanilary glands. Immunological relationships: Active immunity may be dependent on existence of more or less active lessons.

Thermal inactivation. At 51° C in 1

Filterability Passes Berkefeld N filter

candle.

Other properties: Viable in 50 per cent giveerine at least 11 days

Strains An unusually virulent strain. killing infected animals whatever the route of micction, has been described but not given a distinctive name (Rosenbusch and Lucas, Am. Jour. Path., 15, 1939, 202-3101.

Literature . Andrewes, Brit. Jour. Exp. Path . 11, 1930, 23-31, Cole and Kuttner, Jour. Exp Med , 44, 1926, 855-873 , Hudson and Markham, thid., 65, 1932, 405-415; Jackson, Jour. Inf. Dis . 26, 1920, 317-350, Kuttner, Jour Exp Med , 46, 1927, 935-956, Kuttner and T'ung. ibid , 62, 1935, 803-822; Lucas, Am Jour Path., 12, 1936, 933-914, Markham, ibid., 14, 1938, 311-322, Markham and Hudson, abid . 12, 1936, 175-182, Prarson, abid . 6, 1930, 261-274, Scott, Jour Exp Med , 19, 1929, 229-236, Scott and Pruett, Am. Jour Path , 6, 1930, 53 70

3 Rabula innocuus spre nos From Latin ennogues, h trinless

Common name Hamster salisary. ciani virus

Best CRICETIDAL Creciulus grisegs M Ldu . Chinese lamster Insusceptible species WURIDAE-

rat. The musculus I. , white mouse

Geographical distribution China Induced doese. In hamster, no obvi-

ous disease externally but inclusion tento e su automa uttara glamia

Thermal inactivation: At 56° C in 30 minutes.

Literature: Kuttner and Wang, Jcur. Exp. Med., 60, 1934, 773-791.

4. Rabula exiguus spec. nov. From Latin exiguus, petty. Common name: Rat salivary-gland

virus.

Host: MURIDAE—rat.
Insusceptible species: MURIDAE—
Mus musculus L., mousc. CRICETIDAE—Cricetulus griseus M. Edw., Cbi-

nese hamster.

Geographical distribution: China,
Canada.

Induced disease: In rat, no obvious disease externally, but intranuclear inclusions in cells of the submaxillary glands.

Literature : Kuttner and Wang, Jour. Exp. Med., 60, 1934, 773-791; Thompson, Jour. Inf. Dis., 60, 1932, 162-170.

5. Rabula latens spec. nov. From

Common name: Mouse salivary-gland virus.

Host: MURIDAE—Mus musculus L., mouse.

Insusceptible species: MURIDAE—rat. CRICETIDAE—Cricetulus grizeus M. Edw., Chinese hamster. LEPOR-IDAE—rabbit. CAVIIDAE—Cavis porcellus (L.), guinea pig.

Geographical distribution: China, Canada, United States.

Induced disease: In mouse, no obvious disease externally, but inclusion bodies in acinar tissue of serous and mucus pertions of submaxillary glands; occasionally also in duct cells or alveolar cells of parotid gland; affected cells hypertrophied. In Swiss white mice, extensive lesions in liver and spiecn but emulsions of these organs fail to infect; rare panereatic lesions.

Trausmission: Experimentally, by fatraglandular, subcutaneous, intraperitoneal, intratesticular or intracerbral inoculation; inclusion bodies appear in salivary glands irrespective of site of inoculation.

Thermal inactivation: At 60° C in 80 minutes.

Filterability: Passes Berkefeld V filter candle.

candle.

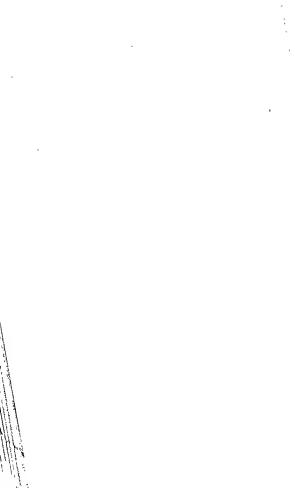
Literature: Kuttner and Wang, Jour.

Exp. Med., 60, 1934, 773-701; McCordock and Smith, 4bid., 63, 1036, 303-310; Thompson, Jour. Inf. Dis., 58, 1936, 69-63

## SUPPLEMENT NO. 3

# PLEUROPNEUMONIA AND PLEUROPNEUMONIA-LIKE ORGANISMS (BORRELOMYCETACEAE)

Louis Dienes Boston, Mau. May, 1915



## THE ORGANISM OF CONTAGIOUS BOVINE PLEURO-PNEUMONIA AND RELATED ORGANISMS\*

#### INTRODUCTION

The organism of bovine pleuropneumonia is similar in certain respects to filterable viruses. Both in infected tissue and in cultures, small elements are present which pass through filters that retain bacteria. The organism is not stained well by the usual bacterial stains and can be made visible only by using special methods. Bovine pleuroppeumonia and other diseases caused by similar organisms were originally attributed to filterable viruses. These organisms are different from viruses in an important point; namely, they grow on suitable media in the absence of fiving host cells. The cuttures consist of pleomorphic elements, the nature of which has only slowly become apparent. By the studies of Nowak (Ann. Inst. Past., 48, 1929. 1330), Turner (Jour. Path, and Bact , 41, 1935, 1) and Klieneberger and Smiles (Jour. Hyg., 42, 1942, 110), it has been established that the pleamorphic forms are part of a reproductive cycle different from binary The small elements in the cultures swell up into large round forms which reproduce the small elements within their membranes. The morphology of the organism is further complicated by the fact that long branching filaments are present in freshly isolated bovine strains. These break un into granules or parts of the filaments swell up into large round forms. In the judgment of some investigators, these properties, in addition to unusual softness and fracility, exclude the organism of bovine pleuropneumonia and similar organisms from the order of true bacteria. Ledinsham (Jour. Path, and Bact., 37, 1933, 393) has classified them with the Actinomyces. Later, Turner (Jour. Path and Bact , 41, 1935, 1) placed them in an independent order, Borrelomucetales, while Sabin (Bact Rev., 5, 1941. 58) has even placed them in an independent class, Paramycetes,

The observations of the present author give support to the classification of Buchanan (Jour Bact, 3, 1918, 40 who placed the genus Asterococcus mycoides Borrel et al. bus type, together with the genus Haemophilus Winslaw et al. in subtribe Haemophilus Buchanan of the tribe Bacteriaer Trevisus cancad Buchanan In many strains of the pleuropneumonia

<sup>\*</sup>Common names have been used through Supplement No. 3 reversit for Astrocessard A. reproducts as the author behaves that a more suntain commendature of an any thus far proposed should be developed who agreement is creded as to the nature of these organisms. Specific names day they are proposed are given no rels as a matter of record. No new names have been included.

group, the small forms appear in appropriate preparations as small bipolar stained bacilli. The transformation of the bacilli to round bodies of variable size often occurs in bacterial cultures and is not specific for the pleuropneumonia group. Furthermore, it has been observed in several species of bacteria that they reproduce in the large round forms in a manner similar to that observed in the pleuropneumonia group. Thus the form variation and reproductive processes observed in the pleuropneumonia group are not specific to this group. They represent general bacterial properties and should be included in the definition of the true bacteria.

According to these considerations, the organisms belonging to the pleuropneumonia group are small, Gram-negative bacilli often showing binolar staining and their distinctive characteristic is the tendency to swell up into round forms and multiply by the reproduction of bacilli in the round forms. Their habitat is in the mucous membranes of animals and man and many of them are pathogenic. They are exacting in their media requirements and usually require fresh animal serum for their growth. These properties indicate a close similarity to the species now included in the genera Pasteurella and Hacmophilus. The pleuropneumonia group might well be classified in the same or a closely related family. It is uncertain whether the strains isolated from earth and sewage should be classified with the strains isolated from animals and men. The soil and sewage strains are less soft, stain more easily and grow abundantly without animal serum. The strains isolated from bacterial cultures are most probably variant forms of the bacteria and should be classified with the parent organisms.

The viruses of psittacosis and lymphogranuloma present similarities to the pleuropneumonia group both in morphology and in their methods of reproduction. This gives added weight to the thought that the pleuropneumonia group represents an intermediary stage in the evolution of the small, Gram-negative bacteria of the mucous membranes into the filterable

viruses.

#### I. THE PLEUROPNEUMONIA GROUP

(Borrelomycetaceae Turner, Jour. Path. and Bact., 41, 1935, 25; Parasitaceae Sabin, Bact. Rev., 5, 1941, 58.)

The organisms are soft and fragile. Without special precautions they are often distorted or entirely destroyed in microscopical preparations. The cultures contain pleomorphic elements. Small grapules, bacilli, bacillary filaments and round forms varying in size from a few tenths of a micron to 10 microns or more Autolyzed round forms may coalesce into large empty blebs. The mund forms are part of a reproductive cycle. They are produced by the swelling of the baculary forms and filaments and reproduce examples or filaments by inside segmentation or multiple segmination. In freshly isolated boying strains, the filaments show apparent or true branching and reproduce the small forms by segmentation. The smallest growing units may not be farmer than 15 to 22 misson and pass through filters that retain bacteria. On agar, tiny colonies (0.1 to 0.6 mm) develop in creat numbers. The colonies invade the near and after 2 to 5 days growth have an oraque center embedded in the agar and a thin prescriberal zone. The surface has a rucced or examilar appearance due to the development and autolysis of the larce forms. After a few days growth, the cultures usually show pronounced autolysis. The parasitic strains require fresh animal serum for growth There is a sincle genus

#### Genus I Asterococcus Borrel et al

(Borrel, Dujardin-Beaumetz, Jeantet and Jouan, Ann Inst. Past., 24, 1910, 179; Coccobacillus Martenovaki, Ann Inst. Past., 25, 1911, 91; Micromyces Frosch, Arch. fo nissensch u prikt. Techeiki, 49, 1923, 35 and 273, not Micromyces Dangeard, Le Botannice, 1, 1885, 55, Mycoplaumo Nowak, Ann Inst. Past., 43, 1929, 1310; Asteromyces Wroblenski, Ann Inst. Past., 47, 1931, 105; Borrelogace Turner, Jour Path. and Bact., 41, 1933, 25, Borrelogace Saban, Bace. Rev., 6, 1911, 57

Characters as for the family

The type species is Asterococcus mycoides Borrel et al

1. Asterococcus mycoldes Borrel et al the microbe de la péripheumonia, Nocard and Hour, Ann Inst Past . 12, 1509, 210. Borrel, Dujardin Beaumetz, Jeantet and Jouan, Ann Inst Past . 24, 1910, 168. Coccobacillus mucasdes nerspaeumonius Martinovski, Ann Inet Past . 25, 1911. 914. Vieromycet perspacumoniae boris contamorae Frosch, Arch f wissensch u prakt Tierhedk . 49, 1921, 35 and 273 . Mycoplasma perspacurioniae Noval. Ann Inst Past , 43, 1929, 1530 , .tstero mures perspacumoniae boris Wroblewsks. Ann Inst Past , 47, 1931, 94, Borrelemyees persparamoniae Turner, Jour Path Bart , 41, 1935, 1, Borimyees plen ropneumoniae Sabin, Bact Rev . 5, 1941, 5: Y

Morphology of cells and appearance of

agar cultures correspond with the description given for the group

Broth cultures are slightly opulescent and, upon shaking, the cultures of fresh strains exhibit still like whorls, due to the presence of long chains and filtiments. The cultures after prolonged incultation consist of small granules.

Blochemical activity Old colonies on serum agar develop a brownish color. Freeldy isolated strains reduce hemoglobin. Glucose, fructose, mannose, maltone, and deaths are fermented with the production of and but no gas. The cultures are but is value.

The strains isolated from eatile are beingenesses in sembgical reactions and distinct from the other members of the group Habitat: It is the causative agent of contagious bevine pleuropneumonia. The disease can be transferred to sheep, goats and water buffaloes, but not to mice, rats, rabbits or other experimental animals.

2 The organism of agalactia of sheep and goats. (Le microbe d'agalacte contagieuse, Bridré and Donatien, Ann. Inst. Past., 39, 1925, 925; Anulomyces agalactue Wroblewski, Ann. Inst. Past., 47, 1931, 111; Borrelomyces agalactic Turner, Jour Path. and Bact., 41, 1935, 25 Capromyces agalactice Sabin, Bact Rev., 5, 1941, 57.)

These organisms are very similar to the former organisms in morphology, appearance of the cultures and growth requirements. Usually the growth is less vigorous, the colonies romain smaller, and the elements of the cultures are more delicate and less easily viable than those of bovine pleuropneumonia. Characteristic crystals develop in the cultures.

Serologically and immunologically this species is distinct from the bovine species.

It is the cause of a systemic disease in sheep and goats with involvement of the joints, eyes, and, in lociating animals, the mammary glands. Other species are not susceptible

3 Pleuropneumonia-like organisms in dogs. (Asterococcus canis, Types I and II, Schoentensack, Kitasato Arch. Exp. Med., 11, 1904, 227; 13, 1936, 175; Canomyces pulmons I and II, Sabin, Bact Rev. 5, 1941, 57)

Both types produce slight uniform opalescence in broth. Typo I grows in granules and coarse colonies and is apparently pathogene for dogs. Type II grows in somewhat larger granular colonies.

They are serologically distinct from each other and from the other members of the picuropneumonia group The connection of these organisms with distemper is not proven.

- 4. Pieuropneumonia-like organisms in rats. L<sub>3</sub> (Klieneberger and Steabben, Jour. Hyg., 57, 1937, 143; Jour. Hyg., 57, 1940, 223; Murimyces pulmons Sabin, Bact. Rev., 5, 1941, 57.)
- L. (Kliencberger, Jour. Hyg., 58, 1938, 458; Murimyces arthritidis Sabin, lor cit.)

The pyogenic virus of Woglom and Varren (Jour. Exp. Med., 68, 1038, 513) and Lr of Findlay, MacKenzie, MacCallun and Kleineberger (Lancet, 27, 1939, 7) are identical with L. The organisms isolated from infected joint by Beeuwkes and Collier (Jour. Inf. Dis., 70, 1942, 1) and Preston (Etd., 70, 1942, 150) probably are identical with L. but they were not typed seriocically.

The requirements for growth, the appearance of colonies and the morphology are very similar to those of the type strain with the difference that long filsments are not observed either in liquid or solid media.

The strains isolated from rate belong to two serological types. Ly was cultivated from chronic lung abscesses, but the number of atrains typed is not sufficient to ascertain that all strains isolated from this source belong to one type. The Ly strains are not pathogenic for rate in artificial infection. They produce suppuration in mice when they are injected with agar.

Le which is serologically different from Le was cultivated from absresses and spontaneous polyarthritis. It produces polyarthritis both in mice and rate. It is not infectious in monkey, rabbits and guinea pigs. Both Le and Le were recovcred from the brains of mice kept in the same zoom with rats.

According to Klieneberger, I., usually produces somewhat larger and coarser colonies than L<sub>1</sub>; L<sub>2</sub> grows in broth in small granules, while L<sub>4</sub> produces an opplescent growth. 5 Pleuropneumonis-like organisms in mice. (Sabin, Science, 88, 1938, 575, and Bact. Rev. 5, 1941, 3; Findlay, Klieneberger, MacCallum and MacKenzie, Lanect, 251, 1933, 1511.) A strans isolated by Sullivan and Dienes (Proc. Soc. Exp. Bool. and Med. 44, 1939, 620) is identical with Type A.

I've groups of atrains, distinct serviogeally, and, to a certain vettent, distinct also in their pathological properties, have been volated from mice. These are types A, B, C, D, and L of Sabin. The atrains are closely similar to each other and to the nat strains. It is questionable whether the slight differences in the appearance of the rolones and in the morphology of the cultures are of significance phology of the cultures are of significance.

Type A (Musculomycea neurolyticus Sabin) is usually present in the conjunctiva and was isolated also from the lung and brain. Intercerebral injection of Type A produces in mice a characteristic rolling disease due to a toxin which is also present in hoth cultures. Intravenous injection produces a transient polyarithritis without dainage to the cartilage of anklous Type A is serologically similario L. of Kheneberger, (Jour Hyg., 40, 1910, 2011).

Type B (Muculomyers arthrotropicus Sabin) was isolated from the limin and from the rassl mucosa. It produces no rolling disease and no soluble town. In mice, intrasensia supertion usually produces a chronic arthritis often leading to ankalous.

Types C. D and E. (Muzulomyres has lottopicus Solim) were isolated from the same location as Type B and produce similar arthritie lessons. They are sero logically destinet from Type B and from each other (Salim, Science, 29, 1939, 18 and Solim and Johnson, Proc. Soc. Lup-Bool and Med., 44, 1910, 52

La redated from mice by Findlay et al. (Trans. Roy. Sec. Trop. Med. Hyg., 52, 1939-40, 6) and the strains of Edward (Jour Path and Bact., 59, 1940, 400) were not compared serologically with the types of Sabin.

6 Pieuropneumonia-like organisms in man. (Dienes, Proc Soc Crp Biol. and Med., 44, 1940, 468, Beveridge, Med Jour of Australia. 50, 1043, 479, Kleineberger, Lancet, 2, 1945, 46)

They are present in about 30 per cent of women in the gentials and they were isolated from suppurstive processes origmating from this source. In men they were found in urethritis, cystitis and chrome prosistitis.

The appearance of the colony, the morphology and growth requirements correspond with the animal strains. The human strains grow less abundantly in serum broth than the animal strains.

One strain was found by Sahin (Proc. Sec. Exp. Biol and Med., 44, 1910, 569) to be serologically different from the strains swhited from ratis and mice. It is not known whether the strains are serologically uniform. There is a slight variation in colony form, in the tendency to grow in fibenesis, and in the abundance of growth, but the variation between the strains is less than the variation due to slightly different cultural conditions.

Mice and rate are usually not susceptible to infection with the human strains, however, several young mice from a single litter were killed in three to six day s by subrutaneous or intrapertunied injection of one strain

7 Pleuropneumonia-like organisms in chick embryos. (Van Herrek and Exton, Jour Ruct, 60 1915, 47)

Organisms have been reduced from clack embryor which conform to the pleatoperasions group with regard to morphology the appearance of colonies on agar and filterability. The cultures agglutinated red I had cells from various annuals. The relation of this stream to the toccolocillary tedies of Nelson (see Section 11) has not been studied.

## II. ORGANISMS OF UNCERTAIN CLASSIFICATION.

Similar to the Pleuropneumonia Group.

 Coccobacillary hodies of Nelson, (Nelson, Science, 32, 1935, 43; Jour. Exp. Med., 65, 1937, 833; Jour. Exp. Med., 72, 1940, 615.)

Nelson isolated a small bacillary organism apparently connected with coryza and infectious catarrh from the masal passages of fowls and from the nasal passages and the middle car of mice and rats. Their size appeared to be 0.3 to 0.4 micron in microscopical preparations and they passed through a filter with a pore size of 640 millimicrons They were isolated in tissue cultures but they grow also in the cell-free and heated supernatant The freshly isolated cultures did not grow on blood or on artificial media; however, after 120 passages to tissue cultures the fowl coryza bodies grew on blood agar slants. On ascitic agar this strain forms colonies very similar to those of the pleuropneumonia group with a dark center surrounded by a thin periphery. The organisms in the top layer are sometimes considerably enlarged, but no weh-like structure is produced. The organism is less soft and the individual organisms maintained their form in the preparations as do bacteria, and the tendency to grow into the agar is less pronounced than in the pleuropneumonia group. The organism isolated from rats is more pleomorphic than the others.

The coccobacillary bodies were not studied with methods appropriate to determine whether they belong to the pleuropneumonia group and whether the mouse and rat strains are identical with the pleuropneumonia-like organisms isolated from roice and rats.

2. Filterable organisms from newage and soil. (Fam. Saprophylaceae Sabiv, Genus Sapromyces Sabin, Bact. Rev., 5, 1941, 59.)

The strains isolated by Laidlaw and Elford (Proc. Roy. Soc. London, B, 120, 1936, 292 : Sapromyces laidlawi AB and C. Sabin, loc. cit.) and Seiffert (Cent. f. Bakt., I Aht., Orig., 189, 1937, 337) according to Orskov (Cent. f. Bakt., I Abt., Orig., 141, 1938, 230) and Klieneberger (Jour. Hyg., 40, 1940, 204) are closely similar to the organisms of the pleuropneumonia group They are filterable, and the smallest reproductive units of those which we have appropriately examined were found to be between .125 and .175 micron. The colonies are similar in appearance to the colonies of the pleuropneumonia group.

The broth cultures consist of granules and round globular elements; the surface layer of agar colonies sometimes surface up into large round forms. They grow without serum, but small amounts of serum accelerate the growth. They grow both at 30° and at 37°C, and remain attive in cultures kept cold for several months. The hroth cultures grow abundantly with a strong opalescence of sediment. Serologically the strains are distinct from the other members of the pleuropneumonia group and all but one are more or less similar to each other.

## III. PLEUROPNEUMONIA-LIKE ORGANISMS ISOLATED FROM BACTERIAL CULTURES.

1. Pleuropneumonia-like organisms isolated from Streptobacillus monififormis. In (Klieneberger, Jour. Path and Bact., 40, 1930, 93; Jour Hyr., 48, 1942, 485; Dienes, Jour. Inf. Des. 66, 1939, 24; Jour. Bact., 44, 1942, 37; Musculomyces atreptobacilli-moniliformis fabin, Baet. Rev., 5, 1911, 57; Heilman, Jour. Inf Dis., 69, 1911, 32; Brown and Nunemaker, Bull. Johns Hopkins Hosp, 70, 1942, 201)

Cultures isolated from different strains

Acid from glucose, maltose, sucrose and mannitol but not from lactose or glycerol.

Starch hydrolyzed.

Ammonia liberated from peptone but no hydrogen sulfide produced

Indole formed in tryptophane sea water bmtb.

Nitrites produced from nitrites

Optimum temperature 20 to 25°C, 30°C incubation will kill recently isolated organisms.

Aerobic, facultative

Source: Isolated from diseased kilifish

(Fundulus partipinnis)
Habitat: Skin lesions and muscle tissue

of infected marine fish.

58. Pseudomonas nigrifacions White (Scientific Agriculture, 20, 1919, 643.)

From Latin riger, black and faciens, making.

Rods: 03 to 07 by I to 5 microns, oc-

cuting singly or in pairs, and having rounded ends. Actively motile, with a single polar flagellum Gram-negative Gelatin stab Promented surface growth

after 1 hours Slight crateriform liquefaction changing to saccate

Ager colonics. Circular, convet,

damiter. Slight fluorescence in early staged. The medium assumes a brownish work.

Agar slant Growth fillform, smooth, mostly glastening, with blackish pigmentationat 4° and 15°C in 48 hrs, the medium furning brownish Shight fluorescence in early stances

Broth Turbid after 24 hours. After 5 to 6 days a black ring and then a pellicle forms, later a black sediment. Medium

turns brown

Litmus milk A black ring appears
after 3 days at 15°C followed by a pellicle.
Litmus us reduced Alkaline reaction.
No exgulation. Digested with a putrid
odor.

Indole not formed.

Nitrites not produced from nitrates in 7 days. No gas produced.

Starch is hydrolyzed Natural fats not hydrolyzed. Alkaline reaction produced in sucrose.

maltose, lactose, glucose, mannitol and raffinose broth (pll 8.2). No gas produced

Ammonia produced in peptone broth.

Aerobic.

Optimum pH 6.8 to 8.4.

Temperature relations: Minimum 4°C. Optimum 25°C. Maximum 33-35°C

Distinctive characters: No or slow growth in culture media in the absence of salt. Maximum growth and pigmentation appeared with 1.5 and 2.5 per cent salt. Optimum pigmentation occurs at 42 and 15°C.

Source: Several cultures isolated from samples of discolored butter.

Habitat Causes a black to reddishbrown discoloration of print butter. Evidently widely distributed in nature.

59 Pseudomonas beijerinekii Hof. (Travaux botaniques néerlandais, 53, 1935, 152.) Named for M. W. Beijerinek, Dutch hacteriologisk.

Small rods: Motile with polar flagella. Gelatin: No liquefaction.

Indole not formed.

Nitrites produced from nitrates by four out of six strains.

Cellulose not decomposed.

Acid from glucose. In yeast-water with 2 per cent glucose and 12 per cent NaCl no gas is produced.

Pigment production: Insoluble purple pigment produced but not in all media; is localized markedly; reduced oxygen tension necessary; optimum pil 8.0; not produced in yeast-water or in persons water; produced only when grown in extracts of beans or some other vegetable. Aembic.

Source: Six strains isolated from beans preserved with salt.

Habitat: Causes purple discoloration of salted beans.

The strains, like the parent organism, are strictly anaerobic and the cultures have the characteristic odor of the parent strain.

It was observed in slide cultures that the L type of colonies develop from large round forms which were produced in the cultures of the parent organism by gradual swelling of the bacteria.

In cultures of eight pleomorphic strains of Bacteroides, the L type of colonies developed in three strains under appropriate conditions. The bacteria swelled into large round bodies in all eight strains. The serological properties of the L strains have not thus far been studied. Neither the parent organisms nor the L type strains had any pathological effect on laboratory animals.

3. Pleuropneumonia-like organisms in a species of Flavobacterium. (Dienes, Jour. Bact., 44, 1942, 37.)

Tiny colonies entirely similar in appearance to young L<sub>1</sub> colonies were isolated from the cultures of a species of Flavobacterium.

The bacterium when freshly isolated produced two types of colonies on blood agar plate; large colonies consisting of small regular bacilli and tiny colonies in which the bacteria became pleomorphic and swelled up to form large round bodies. The tiny colonies after 48 hours of incutation became autolyzed, and one or several L type of colonies started to grow under them. These colonies could be tranplanted and gave abundant growth for two generations, but always died out in the third.

Bacterial forms were not reproduced either on agar or in broth,

The L type of growth was not pathogenic for mice though the parent organism was highly virulent.

 Development of tiny colonies in other hacteria.

The development of tiny colonies similar in appearance to young colonies of the pleuropneumonia group has been observed in cultures of Excherichia on, Haemophilus influenza, and Neisteria genorrhoes (Dienes, Jour. Best. 44, 1942, 37; Proc. Soc. Exp. Biol. and Med., 44, 1940, 476). In all cases preceding their development, the organisms of the parent strains swelled into large round bodies, and in Escherichia coft and Haemophilus influenzae the development of the L type of colonies from these large forms was observed. Thus far these they colonies have not been isolated in pure cultures.

of Streptobacillus moniliformis vary considerably in the appearance of the colonies, the tendency to reversion to bacillary form, and the degree of autolysis. The colonies are considerably larger than the colonies of the human or angual pleuropneumonia-like strains; they may reach I to 2 mm. Usually a wide peripheral zone is present and development and autolysis of the large bodies produces a course appearance in the colonies Sometimes no peripheral zone develops. the colony is dome-shaped, and the large bodies have no tendency to autolyze. The young colonies (thelve hours menbation) grow into the agar as loose strands of more or less suclien granules. Serum broth cultures grow in small clumps usually adhering to the wall of the test tube

The cultures consist of small granules. anall polar-staining bacilly and diphtheroid like forms which swell to large round forms. In the top layer of fully developed colonies, the well-stained large bodies may be as large as 10 to 20 microns By vacuolization they transform suto empty blebs. By segmentation of their contents, the large forms may reproduce the small breillary forms. In suitable preparations chromatin bodies are visible both in the small and large forms The small forms are filterable through Berk. feld candles, the size of the smallest particles has not been exactly determined. The organism is very soft and freede

Their growth requirements and bio chemical activities are similar to those of Strentobacillus monthforms

Growth occurs on justment agar containing animal scrim or erg yolk. Some inner there is a slight growth on boiled blood agar plates without scrim. Good growth is obtained in a indirectal solution with 0.1 per cent starch. Growth is both aerolica and armenolic.

The La form is more resistant to less and to aging of the culture than is the atreptolocillus and it has a remarkable resistance to pencullin to which the loc-

tern are very sensitive. Like the bacillus, La produces acid but no gas from glucose, maltose, fructose, calicin, starch, and detrin. It gives no oxidase test.

Serologically the La form is similar to Steeptobacellus monulaformia and different from the members of the pleuropneumona group. It has no pathological effect on muce, rats or guinea pigs. It does not produce an infection of the chicken embryo. It can be isolated from freally isolated strains of Streptobacellus monulaformis, from several-day old broth and agar cultures, from both cultures leated at 56°C, and usually also from 48 hour agar cultures if they are incubated at 23° to 30°C. It is questionable whether the La form has been isolated directly from rats.

Klieneberger (Jour. 113g., 49, 1940, 201)
solated a similar atrain from a bacterium
anular to Steptobacillus menuliformis
whiel: caused obseesses in guinea pigs.
Whether this bacterium was identical or
different from Steptobacillus monitiforms was not determinate.

2 Pleuropseumonia-like organisms isolated from Bacteroldes funduliformis. Dences (Proc Soc Exp. Biol. and Med., 47, 1911, 385) and Dienes and Emith (Jour Bact, 48, 1911, 125) isolated cultures from two atmins of Bacteroides funduliformis which could be propagated andefinitely and which in morphology and in the appearance of colonics were closely similar to it.

The young relonies consisted of similar strands of granules growing into the medium. The surface of fully developed colonies consisted of large lookies and a lossey comb-like structure. The wilicolated colonies great usually to a fairly large size (I to 2 mm).

Hoth strains, transplanted every two or three days through several months, failed to superline because, "".

tures.

| Amphibia (continued) Toads Arthromitis, 1003 Bacillus, 744, 754  | Animal Products (Vertebrate) Catgut for sutures Bacillus, 815 Gelatin   |
|--|---|
| Micrococcus, 281<br>Serratia, 462<br>Vibrio, 197<br>—, abscesses   | Colony on old plate Micrococcus, 281 Containing iodoform Micrococcus, 272   |
| Micrococcus, 281  —, intestine Spirochaeta, 1066  —, large intestine   | Spoiled Bacillus, 756 Glue Black discoloration  |
| Spirillum, 217 Treponema, 1075 —, rectum Bacterium, 760  | Chromobacterium, 233<br>Hides, salted<br>Pseudomonas, 110   |
| -, tadpoles Bacillus, 742 Tree toads Spirochaeta, 1066   | Sarcina, 289  Animal Sources and Diseases (Inverte- brate) also see Arthropoda, Insects, Mollusca, and Protozos   |
| Spirochaeta, 1000  Amphibia, Discasos of Frogs Pseudotuberculosis Malleomyces, 556 Tuberculosis Mycobacterium, 833, 884, 885, 890 Red leg Pseudomonas, 102, 103  Amphibia, Scientific Names Alytes sp. 712 Bufo americanus, 462, 742, 754, 760 1066, 1075 Hyda septentrionalis, 1066 Leptodactylus occilatus, 1108 Leptodactylus occilatus, 1113 Rana piprins, 462 Rana tampocaria, 742, 754, 1065, 1069, 1070 Nenopus laevis, 439 | Animal Sources (Invertebrate), Common Names Anneliul, Marine Cristispira, 1057 Blood suckers Bacillus, 746 Bacterium, 679 Echinoderm Cristispira, 1056 Leeches Bacillus, 746 Batterium, 679 Tunicate Spirochaeta, 1066 Animal Sources (Invertebrate), Scientific Names Asterius rubens, 1056 Caesara retortformis, 1056 Hirude spp. 679, 746 Hirude spp. 679, 746 Polydow flava, 1057 |
| nimal Diseases (Vertebrate), also see<br>Amphibia, Birds, Fishes, Reptiles,<br>and Mammals<br>Vertebrates<br>Cold-blooded<br>Mycobacterium, 887<br>Warm-blooded<br>Neisseria, 300<br>Pasteurella, 548, 549   | Animal Sources (Vertebrate), also see<br>Amphibas, Birds, Fishes, Repilles,<br>and Mammals<br>Vertebrates, Intestine<br>Aerobacter, 455<br>Escherichia, 417, 449, 450<br>Paraceitobactum, 460<br>Vertebrates, Warm-blooded<br>Salmonella, 503, 510, 517, 528<br>Vibrio, 196   |

## DODEZ.

## SOURCES AND HABITATS

(All references to viruses will be found under the heating (Viruses)

Strentamuces, 935, 969

Abnormal Milk, see Dairy Products Streptothres, 975 AZST Bacillus, 731 Aic Containing iodiform -brewery Micrococcus, 272 Sarcina Digesting bacteria -contamination Acctobacter, 692 Nocardia, 915 Achromobacler, 528 Planococcus, 281 Anarbaelersum, 623, 629, 630 Pseudomonas, 174 Bacterium, 625, 626 Staphylococcus, 232 Flavobacterium, 631 Contamination on cooked potato Pacudomonos, 177, 178, 607, 693, 700 Chromodactersum, 232 Vibria, 200, 203, 201, 702, 703 Air, also see Dust Amehibia, Common Names Mrican toads Actinomyces, 968, 969, 970, 972, 973 Barillus, 617, 648, 649, 650, 651, 650, Vabrao, 197 651, 655, 658, 659, 661, 663, 661, 665, Frogs 607, 668, 660, 670, 671, 672, 738, 741, Bartonella, 1108 Eberthello, 531 742, 743, 741, 747, 748, 749, 750, 751, 752, 751, 756, 758 Flasobacterium, 439 Malleamyces, 556 Baeterium, 602, 613, 672, 674, 676, 678, 680, 681, 761 Micrococcus, 281 Chromobactersum, 232, 233 Mycobactersum, 883, 881, 885, 890 Ctostradium, 803 Pseudomanas, 102, 103 Corvnetacterium, 386 Salmonella, 532 Finrobattersum, 611 - abscesses Gaffi ya. 283 Mierococeus, 281 Leuconostoc, 319 -, feces Micrococcus, 237, 230, 211, 231, 232 Bacillus, 712 253, 255, 256, 260, 261, 268, 271, 272, - intestine 273, 276, 278, 281 Chitin digrating bacteria, 632 Nocardia, 915, 975 Sperochaeta, 1065, 1069, 1070 Pacinia, 696 - Luge intestine Planococcus, 281 Bacillus, 742, 751 l'aculomonat, W. 95, 147, 149, 174 Spirallum, 217 Photocorus, 281 -, wound infections Sarcing, 288, 290 Elerthella, 531 Staphylococcus, 282 Salamander

Pseudomonas, 102

Streptoroccus, 336, 378, 319

<sup>\*</sup>Prepared by Prof. Hobert S. Breed and Mrs Margaret I's Breed, Geneva, New York August, 1917.

t Prepared by Prances O. Holmes, Rockefeller Institute for Medical Research. Princeton New Jersey, July, 1917.

| Arthropoda (continued)                     | Canaries                                    |
|--|---|
| Ticks (continued)                          | Bacillus, 530                               |
| Rhipicephalus sanguineus, 1089, 1096, 1098 | Pasteurella, 554                            |
| Rhipicephalus app., 1088                   | Shigella, 540                               |
| •    | Chaffineh, stomach and intestine            |
| Arthropod Vectors, see Arthropods, and     | Micrococcus, 260, 266                       |
| Insecta                                    | Coot, stomach                               |
|  | Micrococcus, 260, 263                       |
| Bacterial Cultures                         | Crow, stomach contents                      |
| Pieuropneumonia-like organisma, iso-       | Micrococcus, 269                            |
| lated from                                 | Cuckoo, throat                              |
| Bacterordes funduliformis, 1295            | Corynelacterium, 403                        |
| Flavobacterium sp., 1296                   | Dove, intestine                             |
| Streptobacillus moniliformis, 1294         | Bacillus, 666                               |
| Beer                                       | Bacterium, 760, 761, 762                    |
| Acetobacter, 183, 184, 185, 186, 188,      | Micrococcus, 252, 254, 270, 271, 276<br>276 |
| 189  | Sarcina, 202                                |
| Bacterrum, 680                             | Dove, stomach                               |
| Flavobacterium, 441                        | Baclerium, 760                              |
| Pedrococcus, 249, 250                      | Micrococcus, 252, 254, 270, 271, 274        |
| Pseudomonas, 94, 176                       | 276   |
| Bottled                                    | Duck  |
| Micrococcus, 260                           | Borrelia, 1059                              |
| Double                                     | Pasteurella, 552, 554                       |
| Acetobacter, 183                           | Pferfferella, 554                           |
| Ginger                                     | Salmonella, 505, 518, 523, 527              |
| Bacterium, 362                             | Duck, skin                                  |
| Ropy                                       | Corynetacterium, 406                        |
| Acetobacter, 188; 189                      | Finch, intestine                            |
| Streptococcus, 250                         | Micrococcus, 257, 259                       |
| Sarcina-sick                               | -, stomach                                  |
| Pediococcus, 249                           | Bacterium, 761                              |
| Spoiled                                    | Micrococcus, 251, 259                       |
| Achromobacter, 423                         | Flicker, feces                              |
| Lactobacillus, 360                         | Clostridium, 795                            |
| Pedrococcus, 249, 250                      | General                                     |
| Streptococcus, 345                         | Salmonella, 504, 521, 526, 527              |
| Beermash                                   | -, caecura                                  |
| Sported                                    | Treponema, 1075, 1076                       |
| Pedrococcus, 249, 250, 260                 | -, intestine                                |
|  | Bacillus, 648, 651, 652, 653, 655, 658,     |
| Beer Wort                                  | 660, 662, 664, 666, 669, 671, 746, 757      |
| Acctobacter, 183, 185, 186                 | Racierium, 013, 010, 000,                   |
| Bacillus, 758                              | 688, 759, 760, 101, 102                     |
| Inflabilis, 823                            | Micrococcus, 269                            |
| Lactobacterium, 363, 364                   | Pseudomonas, 147, 149                       |
| Pseudomonas, 146                           | Vabrio, 196                                 |
| Birds, common names                        | -, not pathogenic for                       |
| Bullfinch                                  | Piscine tuberculosis Mycobacterium 883      |
| Prelattera 1895                            | Blycobacterrum coo                          |

| Arthropoda, Common Names           | Gammarus 2scholker, 678    |
|------------------------------------|----------------------------|
| Arachnida                          | Lamulus polyphemus, 632    |
| Rickettara, 1008, 1009             | Talarchestia sp , 111      |
| Crustacea                          | Millipeds                  |
| Crayfish, intestine                | Julus marginatus, 1003     |
| Chitin-digesting bacteris, 632     | Mites                      |
| Fresh water                        | Allodermanyesus sanguin    |
| Bacterium, 678                     | Trombicula akamushi, 10    |
| Pasteuria, 836                     | Trombicula deliencis, 100  |
| Horseshoe crab, shell              | Trombicula fletchers, 1091 |
| Bacterium, 632                     | Trombicula walchi, 1091    |
| Marine                             | Ticks                      |
| Bactersum, 635                     | 1mblyomma americanum,      |
| Small crustacea                    | 1038                       |
| Eubaclerium, 367                   | Amblyomma brasiliensis,    |
| Parteuria, 836                     | Amblyomma cazennense,      |
| Myrapoda                           | Amblyomma hebraeum, 10     |
| Diplopeda                          | .lmllyomma maculatum,      |
| Funformia, 874                     | Amblyomma spp. 1088        |
| Millipeds, intestine               | .lmblyomma striatum, 10x   |
| Arthromitia, 1003                  | imblyomma cartegatum,      |
| Mites                              | Boophilus decoloratus, 1   |
| Rickettina, 1008                   | Dermacentor albipicius,    |
| Haemobartonella, 1105              | Dermacentor andersont,     |
| Bird mites                         | 1006, 1008                 |
| Richettera, 1031                   | Dermacentar occidentalis,  |
| Human mites                        | Dermacentor spp , 1088     |
| Ricketterg, 1011, 1092             | Dermacentor ramabilis, 16  |
| Redent mites                       | Haemaphysalis humerasa     |
| Ricketting, 1991, 1972             | Haemophy alis leacht, 100  |
| Spiders                            | Hacmophysalia lepori       |
| Rickettina, 1018                   | 1088, 1003                 |
| Ticks                              | Baemophyralis app. 1089    |
| Borrelia, 1057                     | Hyalomma spp , 1075        |
| Haemobartonella, 1105              | Ixodes dentatus, 1088, 10  |
| Klebssella, 450                    | Melaphagus oranus, 1008,   |
| Rickettina, 1097, 1078, 1099       | Ornitholoror erraticus, 1  |
| Spirocharta, 1968                  | Ornitholoros hermsi, 1961  |
| Bont ticks,                        | Ormithofores latiorensis,  |
| Rickettera, 1083, 1991             | Ornithadoras maracanus,    |
| the ticks, 1088, 1096, 1098        | Ornithalores moulata, 10   |
| Rickettina, 1088, 1059, 1096, 1098 | Gratholores normands, 1    |
| Italibut ticks                     | Ornitholoros parkers, 100  |
| Rickettna, 1988                    | Ornithedoros rudis, 1061   |
| Sheep ticks                        | Ornetholoros spp. 1963.    |
| Rickettera, 1097                   | Ornetholoros tholosani, 1  |
| Word ticks                         | Oratholores turicale, 10   |
| Rulettein, 1988, 1071, 1996        | Granthalores renesuelens   |
| Arthropeda, Scientific Natrea      | Theperephalus appendies    |
|                                    | Discount of the same       |

Darknig on , 836

ulus volunkemus, 632 archestia sp . 111 eds us maronnatus, 1003 edermanussus sanguineus, 1072 mbienla akamushi, 1091 mbicula deliencis, 1001 mbreula fletchert, 1091 mbienla walchi, 1001 bluomma americanum, 1088, 1093, bluomma brasiliensis, 1088 bluomma cajennense, 1088 bluomma hebraeum, 1089, 1094 Uyomma maculatum, 1008 blyomma spp. 1068 bluemma striatum, 1988 blyomma variegatum, 1071 philus decoloratus, 1089 macentor albipicius, \$59 maccalor andersons, 1083, 1093, 996, 1998 macentar occidentalis, 1993 macenter spp. 1088 macentor ramabilis, 1058 emophysalis humerosa, 1003 emophysalis leacht, 1089 cmaphysalis leporis-palustria, 088, 1093 emophyratis app. 1088 alomma spp, 1095 des dentatus, 1088, 1093 lophogue oranue, 1008, 1007 atholoros erratieus, 1066 utholoros hermet, 1961 uthofares latiarensis, 1003 eitheiteres marecanus, 1967 nithedores moubata, 1060 nithelores normands, 1978 nithaloros parkers, 1061 nithedoros endis, 1064 attholoros spp. 1963, 1968 atholoros thelozani, 1000 attholores turicala, 1064 nithaloras renezuelenia. 1964 specephalus appendiculatus, 1041 Chapterpholus burea. 1017 Rhaptershalus deceloratus, 1962

Birds. Diseases of (continued) Bovine tuberculosis Canaries (continued) Mycobacterium, 879 Intestinal catarrh and liver changes Human tuberculosis Bacillus, 530 Mycobacterium, 878 Septicemia Nodules, kidney, lung, spleen Shigella, 540 Streptococcus, 342 Chicken, see Poultry Parrot fever Chicken embryos Miyagawanella, 1117 Pleuropneumonia-like disease, 1293 Psittacosis Cockatoo Miyagawanella, 1117 Bovine tuberculosis Pheasants Mycobacterium, 879 Epidemic in Crossbills Bacterium, 552 Infectious disease Ornithosis Bacillus, 661 Meyagawanella, 1117 Dove Piecon Ornithosis Avian tuberculosis Mayagawanella, 1117 Mycobacterium, 881 Ducklings Diphtheria Reel Bacillus, 400 Salmonella, 523 Bacterium, 401 Ducks Poultry Septicemia Abscesses, epidemic Pasteurella, 552 Sphaerophorus, 579 Pfeiffcrella, 554 Chicken cholers, blood Finches Micrococcus, 262 Ornithosis Chicken cholera-like disease Mayagawanella, 1117 Proteus, 489 Fulmar petrels Conjunctivitis, acute Ornithosia Colesiota, 1120 Miyagawanella, 1117 Coryza Geese Coccobacillary bodies of Nelson, Septicemia 3291 Shigella, 543 Diphtheria Spirochaetosis Bacterium, 674 Borrelia, 1059 Corynebacterium, 385 General Fowl cholera Avian tuberculosis Bacterium, 612 Mycobacterium, 881 Salmonella, 521 Cholera-like disease Fowl typhoid Vehrio, 196 Proteus, 489 Diphtheria Salmonella, 521 Bacillus, 400 Hemorrhagic septicemia Diphtheria-like disease Pasteurella, 547, 549 Actinomyces, 915 Keratitis Hemorrhagic septicemia Colesiola, 1120 Pasteurella, 549 Lesions, tuberculous Pleuropneumonia-like disease, 1293 Mycobacterium, 880 Grouse Limberneck Bacillus, 668 Clostridium, 780 Parrot

| Birds (continued)                       | - human tuberculosis                       |
|---|--|
| Turtle tuberculosis                     | Mycobacterium, 878                         |
| Mycobacterium, 886                      | - spicen                                   |
| -, stomach                              | Mycobacterium, 890                         |
| Bacillus, 617, 648, 652, 653, 655, 658, | -, threat                                  |
| 660, 662, 661, 666, 657, 669, 671.      | Coruncbacterium, 403                       |
| 740, 749, 751, 757                      | Quail                                      |
| Bactersum, 686, 759, 760                | Salmonella, 510, 521                       |
| Micrococcus, 260                        | Robin, feces                               |
| Preudomonas, 146, 147                   | Bacillus, 756                              |
| Grouse                                  | Rock dove, stomach and intestine           |
| Salmonella, 521                         | Micrococcus, 252, 270, 276                 |
| -, blood and intestine                  | Sarcina, 293                               |
| Spirochaeta, 1067                       | Sampe, intestine                           |
| Guinea fowl                             | Chitin-digesting bactern, 632              |
| Clostridsum, 796                        | Sparrow, intestine                         |
| Hedge sparrow, stomach                  | Micrococcus, 270, 273, 291, 293            |
| · Micrococcus, 252, 270, 273            | -, stomach                                 |
| Parrots                                 | Baelersum, 761                             |
| Miyagawanella, 1117                     | Microe occus, 291, 293                     |
| Salmonella, 532                         | Starling, intestine                        |
| -, nasal secretions                     | Micrococcus, 257, 263, 272, 273            |
| Miyagawanella, 1117                     |  |
| Partridge                               | -, stomach Micrococcus, 257, 263, 272, 273 |
| Salmonella, 525                         | Sareina, 291                               |
| Pheasant                                | Teal, enecum                               |
| Bacterium, 552                          | Treponema, 1076                            |
| Clostridium, 746                        | Turkey                                     |
| Mayagawanella, 1117                     | Salmonella, 519, 512, 513, 511, 519        |
| Kalmonella, 521                         | 521, 523, 527, 528                         |
| Pigeons, diwased                        | Turkey poults                              |
| Bacillus, 400, 652                      | Lactobacellus, 407                         |
| Bactersum, 401                          | Salmonella, 501, 505, 514, 515, 523,       |
| Eryst pelothras, 111                    | 827, 528, 529                              |
| Haemokartonella, 1101                   | Woodpecker, intestine                      |
| Mycobactersum, 891                      | Micrococcus, 251, 200, 272                 |
| Salmonella, 503, 532                    | Sarcina, 200                               |
| Poultry                                 | kellow hammer, intestine                   |
| Salmonella, 502, 505, 507, 509, 510,    | Micrococcus, 259, 263, 265, 272            |
| 511, 512, 513, 514, 516, 518, 519,      | Sarcina, 202                               |
| 521, 522, 523, 525, 526, 528, 529, 530  |  |
| -, execum                               |  |
| Trepmena, 1075                          | -Micrococcus, 259, 261, 263, 272           |
| -, ery throcy tes                       | Blate Blasses of                           |
| Graf omella, 1119                       | Birds, Diseases of                         |
| -, intestine                            | Bards of prey                              |

Saterna, 272

-, ment parentes, 1231

-, rost pathogenic for

Mycdattenum, 872

Borine tuberculous

Infectious necrosis

Pastewella, 551

Canaries

Myerbacterium, 879

Borrelia, 1062

Cattle. Diseases of (continued) Septicemia Salmonella, 514 Kemtitis Streptococcus, 317 Colesiota, 1119 Streptotrichosis, skin Moraxella, 592 Actinomuces, 968 Lamziekte Suppurative lesions Clostridium, 779 Staphylococcus, 282 Lesions, tuberculous Symptomatic anthrax Mycobacterium, 879 Clostridium, 776, 822 Light febrile disease Tuberculosis, bovine Rickettsia, 1095 Bacillus, 652 Listeriosis Mycobacterium, 877, 879 Listeria, 409 Ulccrations, mouth region, calves Lumpy jaw Bocillus, 747 Actinomyces, 926 Ulcerative lesions Mastitis Corynebacterium, 389 Bacillus, 662 White diarrhoea of calves Chlorobacterium, 693 Streptococcus, 345 Corymebacterium, 401 Galactococcus, 250 Cellulose Digesting Bacteria Bacillus, 737, 743, 746, 756, 814 Tetracoccus, 284 Streptococcus, 320, 341 Bacterium, 614, 615, 633 Cellulobacillus, 762 Metritis Cellulomonas, 617, 618, 619, 620, 621 Streptococcus, 317 Necrotic foci in liver 622, 623 Sphaerophorus, 579 Cellvibrio, 210 General, 1006 Ophthalmia, infectious Itersonia, 1014 Colesiota, 1120 Micrococcus, 259 Peripneumonia Pseudomonas, 145, 147, 148 Pneumococcus, 697 Spirochaeta, 1053 Pink eye Sporocytophaga, 1049, 1050 Moraxella, 592 Vibrio, 203, 204, 205, 206, 207, 703 Pleuropneumonia Ascococcus, 1291 Cheese Aerobacter, 456, 157 Streptococcus, 345 Bacillus, 612, 617, 669, 712, 734, 743, Pneumonia 745, 750, 814, 815, 816, 824, 825 Pasteurella, 549 Bacterium, 676, 677, 678, 670, 681, 683, 686, 689, 758, 760, 761, 762, Pneumonia, contagious Bacıllus, 664 Purulent infections, urinary tract Clostridium, 770, 810, 820, 822, 824 Corynebacterium, 389 Escherichta, 452 Granulobacillus, 826 P118 Lactobacillus, 351, 352, 356, 357, 359 Corynebacterium, 388, 405 Microbacterium, 370, 371 Micrococcus, 264 Micrococcus, 241, 243, 251, 256, 258, Streptococcus, 343 264, 265, 266, 269, 270, 277, 279, Pyelonephritis Corynebacterium, 389 Propionibacterium, 373, 374, 375, Rauschbrand 376, 377, 378, 379 Sarcina, 290, 291, 292, 293 Clostridium, 820, 825 Streptococcus, 325, 326, 340, 344 Relapsing fever

Birds, Diseases of (continued) Picus major, 251, 260, 272, 290 Purrhula europea, 1095 Listeriosis Querquedula querquedula, 1076 Lasteria, 400 Ocular mup Squatarola squatarola, 1076 Sturmus vulgaris, 237, 263, 272, 273, Colesiota, 1120 Centiforms 201 Mayagawanella, 1117 Blue Milk, see Dairy Products, Abnormal Rhinitis, infectious Milk Hemophilus, 580 Roup Bovine Diseases and Sources, see Cattle Baetersum, 674 Sentucemia Butter Bucterium, 612 Actinomyces, 974 Support tendon Aerobacter, 456 Streptococcus, 317 Bacallus, 743 **Epirochaetosia** Bacterium, 590, 602, 676 Spirochaeta, 1039 Chromobactersum, 231 Tulerculosis, axian Lactobacellus, 357 Mycobacterium, 879, 880 Leuconostoc, 348 Tumors in abdominal cavity Mecrobacterium, 371 Actinomyces, 918 Micrococcus, 260, 261, 265, 266, 279 White diarrhoes Mucobacterium, 889, 890 Salmmella, 521 Nocardia, 905 Swan Preudomonas, 148 Cholera Sarenna, 201 Bacillus, 551 Streptococcus, 325, 337, 339 Infectious disease Black to reddish brown discoloration Haclerrum, 612 Pseudomonas, 109 Turkeys Fruits aroma Pacumpearditis Macrococcus, 260 Borillus, \$62 May apple to stranberry odor Wild pigrons Pseudomonas, 100, 101 l'audemie in Baetersum, 552 Bancid Barillus, 650, 650, 660, 811, 816 Ilird's Nest Microcoreus, 251 Myzaccecus, 1012 Stunk odor Birds, Scientific Names Pseudomonas, 99 Colopies auraius, 745 Tainted Columba Isria, 252, 270, 276, 293 Pseudomonas, 99, 100, 101, 109 Columba ornas 252 254, 270, 271, 274, Butternull 276, 272, 760, 761 Hacellus, 611 Corena corone, 2011 Propromibacterium, 374, 375, 377 I miscaca carrinella, 209, 263, 265, Serratra, 451 272 272 f empella cardvelas, 257, 259 Maurens) Fringella codela, 200, 200 Closterdium, 823 I ulica atra, 200, 203 Gallus op . 1073 Calf Diseases and Sources, see Cattle Larerus rections, Con. 1947 Large redition las, 1075 Cats Paster mentance, 212, 270, 273, 241, Inne

Mayagawanella, 1115

217

60. Pseudomonas sallnarla Hnrrison and Kennedy, (Harrison and Kennedy, Trans. Royal Soc. of Canada, 16, 1922, 121; Serratia salinaria Bergoy et al., Manual, 1st ed., 1923, 93; Flavobacterium (Halobacterium) salinarium Elazari-Volcani, Studies on the Microflora of the Dead Sea, Thesis, Hebrew Univ , Jerusalem, 1940, 59) From Latin, salinne, saltworks.

Probable synonym: Serratia sambharianus Dixit and Vachna, Current Sci., 11, 1942, 107 (see Biol Abs., 17, 1943, 793). Halophilic growing in 30 per cent salt. From salt lake in India

Occurs as spheres and rods, 20 to 30 microns in diameter, 1.0 to 1.6 by 3.0 to 150 microns, occurring singly, as ovoid, amoeboid, clavate, cuncate, truncate, spindle, club, pear-shape, and irregular forms. Motile, frequently with

n flagellum at each pole Gram-negative.

Does not grow on ordinary culture
media. Grows well on salted fish.

Codfish agar (16 to 30 per cent salt): Growth slow, smooth, raised, coarsely granular, entire, pale pink to scarlet (Ridgway chart).

No acid from carbohydrate media.

Indole not formed.

Nitrites not produced from nitrates.

Aerobic, facultative

Optimum temperature 42°C.

Source: Isolated from cured codfish (Harrison and Kennedy, loc. ctt ) Isolated from salted fish by Browne (Abste Bact., 6, 1922, 25 and Proc. Soc. Exper. Biol and Med., 19, 1922, 321) who regarded this pleomorphic bacterium as two organisms—Sprochaeta halophihea and Bacterium halophihus

Habitat: Produces reddening of dried codfish and causes rusty herring. In sea salt, and salt ponds containing not less than 16 per cent salt

Pseudomonas cutirubra Lochhead.
 (Serratia cutirubra Lochhead, Can. Jour.

of Research, 10, 1934, 275; Bacterium cutirubrum Lochhead, Jour. Bact., 27, 1931, 62; sbid., 45, 1943, 575; Flacobacterium (Halobacterium cutirubrum Elazari-Volcani, loc. cit., 59.) From Latin, cutis, skin, hide; ruber, red

Occurs as rods and spheres. Spheres 1 to 1.5 microns in diameter. Rods 1.5 to 8.0 by 0.7-1.4 microns. Rod forms motile with single polar flagellum. Coccoid forms motile when young. Gramnecative.

No growth on ordinary media.

Milk agar (20 per cent salt to saturation; optimum 28-32 per cent): Colonies 3-4 mm, in diameter, round and slightly convex. Pink to rose dorée (Ridgway chart).

Milk ngar slants: Growth filiform, slightly spreading, rather flat with smooth, glistening surface and membranous consistency. Proteolytic action.

Liquid media: No or slight growth.
Gelatin (salt): Pronounced liquefaction.

Indole not formed, Lochhead (loc. cit.), Faint test, Gibbons (Jour. Biol. Board Canada, 3, 1936, 75).

Nitrates not produced from nitrates.

Diastatic action negative.

No carbohydrate fermentation.

Aerobic, obligate.
Optimum temperature 37°C.

Halophilic.

Source. Isolated from salted hides. Habitat: Sea water and sea salt.

62. Pseudomonas harveyi Johnson comb. nor. (Achromobacter harveyi Johnson and Shunk, Jour. Bact., 31, 1936, 587.) Named for E N. Harvey, who studied luminous bacteria.

Rods: 0 5 to 1.0 by 1.2 to 2.5 microns, occurring eingly or in pars, with rounded ends Occasionally slightly curved; ends occasionally slightly pointed. Non-spore-forming. Capsules absent. Motile with a single polar flagellum, 2 to 3 times the length of the cell Gram-negative.

| Cheese (continued)         | Aruchater                            |
|----------------------------|--------------------------------------|
| Tetracoccus, 284           | Streptococcus, 342                   |
| Tyrothrix, 823             | Oka                                  |
| Vibrio, 197                | Bacierium, 602                       |
| Bitter                     | Parmesan, see Grana                  |
| Streptococcus, 323 -       | Bacillus, 737, 756                   |
| Black Drecoloration        | Richelieu                            |
|                            |                                      |
| Bacterium, 678             | Micrococcus, 695                     |
| Garsy curd                 | Schlosskäse                          |
| Bacillus, 672              | Streptococcus, 312                   |
| Pasteurized                | Soft                                 |
| Actinomyces, 968           | Bacillus, 649                        |
| Red                        | Salmonella, 529                      |
| Plocamobactersum, 691      | Swiss                                |
| Rusty spot                 | Bacellus, 618, 657, 737, 739, 752    |
| Lactobacellus, 357, 359    | Bactersum, 688, 759, 760             |
|                            | Micrococcus, 255, 256, 257, 259, 26  |
| Cheese, Types of           | 263, 264, 269, 270, 273, 275, 27     |
| Blue                       | 231                                  |
| Hactersum, GB              | Propromineterium, 373, 374, 379      |
| Hrick                      | Sarcina, 200, 201                    |
| Bactersum, 602, 761        |                                      |
| Brie                       | Streptococcus, 323, 338              |
| Streptococcus, 311         | Tubit                                |
| Camembert                  | Plocomobacterium, 031                |
| Bactersum, 602             | Propionebacterium, 378               |
| Microroccus, 200, 203, 263 | Chitin Digesting Bacteria            |
| Sarcina, 277               | Bacillus, 632                        |
| Telracorous, 281           | Bacterium, 632                       |
| Cantal                     | rational, the                        |
| Streptococcus, 337         | Concrete, see Mineral Sources        |
| Cheddar                    |                                      |
| Bactersum, 602             | Condensed Milk, see Dairy Products   |
| Pseudommas, 697            | Contamination                        |
| Cream                      | Bacillus, 712, 717, 748              |
| Bacillus, 664              |                                      |
| Streptocercus, 340         | Bacterium, 601, 673, 682             |
| lalam                      | Cellulomenas, 622                    |
|                            | Chromobacterium, 233                 |
| Chromokacterum, 233        | Clastridium, 798                     |
| Peoploatbacterium, 37h     | Corpsebortersum, 40k                 |
| Emmental, see Pages        | Necardia, 905, 915                   |
| Gouds                      | Oorpora, 976                         |
| Barillus, 663              | Planerorus, 281                      |
| Streptocoreia, 312         | l'etudommas, 174                     |
| Cirata                     | Staphyloroccus, 282                  |
| Barillus, 756              | Tuberculin flask                     |
| Lamburget                  | Normain, 2025                        |
| Bucillus, 612              | Varcane                              |
| Bactersum, All             | Ostpora, 376                         |
| Martinerus, 2d., 201       | Cream, see Milk and Cream            |
| Laptauer                   | _                                    |
| Banillur, 816, 826         | Cutting Compound. are Mineral Source |
|                            |                                      |

Bacillus, 362

Dairy Products, also see Butter, Cheese, Kefir and Milk and Cream Bacillus, 746 Abnormal milk Lactobacillus, 351, 357, 359 Bitter flavor Streptococcus, 338 Kumys Bacillus, 618 Bacillus, 362 Micrococcus, 265 Leben Blue milk Streptobacillus, 364 Pseudomonas, 93, 145 Matzoon Fetid odor Flavobacterium, 441 Viscobacterium, 601 Sarcina, 252 General Mazun Achrombacter, 600 Bacillus, 748 Red milk Bacterium, 362 Bacterium,, 601 Piima. Micrococcus, 256 Streptococcus, 342 Rapy milk, also see Slimy milk Tactte Achromobacter, 427 Lactobacillus, 695 Streptococcus, 702 Alcaligenes, 414 Tactte, false Lactabacellus, 695 Bacterium, 675 Micrococcus, 258, 268, 271 Yoghurt Streptococcus, 344, 702 Lactobacillus, 355, 362, 364 Slimy milk, also see Ropy milk General Achramobacter, 425 Bacillus, 732, 733 Bacellus, 651, 746 Micrococcus, 237, 239, 240, 241 Bactersum, 601, 675 Mycobacterium, 889 Closindium, 789 Propionibacterium, 373, 374, 375, Flavobactersum, 431, 442 376, 377, 378, 379 Micrococcus, 268, 271 Pseudomonas, 100 Soapy milk Ica cream Bacillus, 660, 667, 758 Bacillus, 612, 670 Pseudomanas, 145, 149, 150 Malted milk Tainted Bacillus, 756 Bacillus, 660 Milk powder Aroma bacteria Bacillus, 733, 755, 756 Streptococcus, 339 Milk powder (spray process) Cascinate solution Streptococcus, 328 Achromobacter, 692 Sour milk Condensed milk Bacillus, 756 Leuconostoc, 348 Lactabacillus, 352, 362, 361 Thermobacterium, 364 Starters Evaporated milk Leuconostoc, 317, 348 Bacillus, 713, 738 Streptococcus, 325 Pseudomonas, 163 Whey Fermented milk Bacillus, 755, 756 Dadhi Bacterium, 687 Streptothrix, 364 Dairy Utensils General Alcaligenes, 414 Sarcina, 292 Bacillus, 732, 733 Gioddu Microbacterium, 370, 371

| Dairy Utensils (continued)              | 7 |
|---|---|
| Micrococcus, 238, 239, 240, 241         |   |
| Pseudomonas, 100                        | C |
| Creamery equipment                      |   |
| Pseudomonas, 99                         |   |
| Farm utensils                           |   |
| Sarcina, 294                            |   |
| Filter cloth                            |   |
| Bacillus, 735                           | 3 |
| Milk can                                | _ |
| Serratia, 481                           | 1 |
| Milking machine                         | _ |
| Sarcina, 201                            |   |
| Dairy Wastes                            |   |
| Achromobacter, 628                      | 4 |
| Flavobacterium, 433                     | • |
| Pseudomonos, 177, 178                   | 5 |
| Decomposing Materials                   |   |
| Agar-digesting bacteria, see Agar Di-   | , |
| gesting Bacteria                        |   |
| Cellulose-digesting bacteria, see Cell- |   |
| ulose Digesting Bacteria                |   |
| Cellulore fibers                        |   |
| Sorangium, 1024                         |   |
| Chitin-digesting bacteria, 632          |   |
| Composts                                |   |
| Cellulomanas, 618                       |   |
| Micromonaspora, 980                     |   |
| Streptomyces, DS7                       |   |
| Thiobacittus, 79, 81                    |   |
| Crab shells                             |   |
| Bacterium, 632, 633                     |   |
| Farinsceous materials                   |   |
| Clostrideure, 821                       | _ |
| General                                 | D |
| Bacillus, 711, 715, 730, 733, 731,      |   |
| 735, 741, 743                           |   |
| Bacterium, 682                          |   |
| My recovers, 1012                       |   |
| Spirillum, 701                          |   |
| Grass                                   |   |
| Actinomyces, 973                        |   |
| Bocillus, 756                           |   |
| Marococus, 1012                         |   |
| Myroraeur, 1012                         |   |

Archangium, 1015, 1019

Maxemerus, 1012

Booling, 743, 751

Litrius solution

farme vegetation Cutaphaca, 1014, 1015 manie Matter Chondrococcus, 1016 Cutophaga, 1014 Polyanaum, 1028, 1029, 1030 Sorannium, 1023 Vibrao, 201, 203 aper Muxococcus, 1042 Pant residues Bacterium, 824, 825 Clostrodium, 825 Cutophaga, 1013 starchy materials Bacillus, 722 Sucar refinery waste Lampropedia, 811 Cretable Bacellus, 721 Spirellum, 214 Container 1 Baeillus, 815, 819 Thiothriz, 989 Wood Chondromuces, 1007, 1000 Clostridium, 825 Myzococcus, 1012 Synangium, 1033 Watermelon Bacellus, 743, 751 Water plants Lampropedia, 514 023 Bile Bacteroides, 506

Clostedium, 823
Myzocceu, 1012
Synangum, 1033
Waternelon
Bacillus, 748, 751
Water plants
Lampropedia, 544
Ocs
Blub
Batteroides, 566
Blood
Leptospira, 1078
Spirochaeta, 1066
Streptocceus, 213
Conjunctiva
Corynbacterium, 405
Lry throcytes
Haendoutonella, 1104
Fatal illness
Rucktitia, 1045
Feeca
Bacillus, 815
Sedermida, 514, 520, 555

|                                       | **  |
|---------------------------------------|---|
| Dogs (continued)                      | Haemobartonellosis  |
| Genital organs                        | Haemobartonella, 1102   |
| Salmonella, 514, 529, 539             | Hemorrhagic septicemia  |
| Intestine                             | Pasteurella, 549, 550, 553  |
| Bacterium, 680                        | Human tuberculosis  |
| Salmonella, 514, 529, 530             | Mycobacterium, 878  |
| Spirochaeta, 1068                     | Leukemia  |
| Liver                                 | Bacterium, 680  |
| Acuformis, 812                        | Streptococcus, 337  |
| Nasal mucosa                          | Lymphadenitis   |
| Zuberella, 578                        | Nocardia, 919   |
| Nasal mucus                           | Measles   |
| Bacillus, 740                         | Streptococcus, 341  |
| Not pathogenic for                    | Peritonitis   |
| Mycobacterium, 880                    | Actinomyces, 915  |
| Nocardia, 896                         | Phlegmon  |
| Preputial secretions                  | Actinomyces, 915  |
| Hemophilus, 588                       | Plague  |
| Red blood cells, see Erythrocytes     | Spirochaeta, 1068   |
| Skin                                  | Pleuropneumonia-like disease  |
| Corynethrix, 406                      | Asterococcus, 1292  |
| Stomach                               | Pneumonia   |
| Bacillus, 651, 671                    | Brucella, 563   |
| Spirillum, 217, 218                   | Purulent infectious, urinary tract  |
| Spirochaeta, 1069                     | Corynebacterium, 389  |
| Throat                                | Pyorrhoes   |
| Streptococcus, 315                    | Leptothrix, 366   |
| Urine                                 | Rabies, vaccine contaminant   |
| Bacillus, 740                         | Flavobacterium, 437   |
| · · · · · · · · · · · · · · · · · · · | Rabies-like disease   |
| Dogs, Diseases of                     | Bacillus, 663   |
| Abortion                              | Ringworm  |
| Brucella, 562                         | Actinomyces, 916  |
| Abscess                               | Uremia  |
| Micrococcus, 273                      | Leptospira, 107:  |
| Actinomycosis                         | Dung, see Manure (Dung)   |
| Actinomyces, 927                      | Done also was Air.  |
| Bronchitis                            | Achromobacter, 424, 425, 427  |
| Nocardia, 919                         | Actinomyces, 968, 970   |
| Cancerous ulcers                      | Actinomyces, 968, 970  Bacillus, 712, 717, 723, 725, 726, 727  Bacillus, 712, 733, 734, 735, 736, 737     |
| Spirochaeta, 1074                     | Bacillus, 712, 717, 723, 725, 736, 737<br>730, 731, 732, 733, 731, 735, 736, 737                          |
| Catarrh                               | 738, 739  |
| Pseudomonas, 146                      | Dasterium, 605, 682   |
| Cerebromeningitis                     | ot charlerillin, 200  |
| Nocardia, 919                         | Clostridium, 786, 817, 820  |
| Distemper                             | Diplococcus, 309  |
| Brucella, 563                         | Diplococcus, 309 Micrococcus, 237, 239, 240, 243, 244 Micrococcus, 258, 257, 258, 259, 260, 252           |
| Endometritis                          | Micrococcus, 237, 239, 259, 260, 262<br>253, 255, 256, 257, 258, 259, 260, 262<br>253, 275, 276, 277, 278 |
| Bacterium, 677                        | 264, 200, 200, 200,   |
| Glanders                              | 279, 280, 281   |
| Malleomyces, 555                      |   |

Dust (continued) Miugoawanella, 1117 Mucobacterium, 889, 890 Sarcina, 280, 290, 292, 293 Serratia, 484 Streptococcus, 316, 340 Streptomyces, 935, 936, 949 Dusts

Stable

Micrococcus, 265 Street

Clostridium, 786, 820

Eggs, see Foods and Foodstulls Evaporated milk, see Dairy Products

Feces, Animal, see Manure (Dung)

Feces, Human

Also see Human Sources, Intestine Aerobacter, 436, 437 .11colinenes, 413, 416 Hacellus, 612, 647, 651, 652, 654, 656, 661, 662, 665, 666, 668, 721, 736, 737, 738, 744, 746, 748, 749, 753, 755, 756,

813, 817, 815, 825, 826 Bactersum, 601, 607, 673, 675, 681, 693, 687, 759, 760, 761, 762

Bacteroides, 507, 508, 509, 570, 571, 572, 573, 574, 575

Bifidobacterium, 300 Colenabactersum, 368

Clastridium, 773, 774, 782, 785, 787, 788, 791, 793, 794, 796, 797, 799, 600, 801, 802, 809, 810, 611, 812, 820, 621,

822, 821, 826 Corynebacterium, 401 Eberthella, \$33, \$31

Escherichia, 417, 450, 451, 452, 453 Eulacterium, 368 Granulokacıllus, 826

Kurthia, 613 Lartoborillus, 353, 351, 357, 359, 362 Macrobacterium, 370

Metrococcus, 252, 253, 257, 259, 260, 274, 276, 270, 272, 274, 273, 276, 277, 275, 277, 247, 251, 673

Microspira, 20 15 etcus, 455, 470, 471 Paradomonas, 50, 169 Hambarterium 200

Salmonella, 502, 501, 505, 506, 510, 511, \$12, \$13, \$14, \$15, \$17, \$18, \$19, \$20, 522, 521, 525, 526, 527, 528, 529, 530,

Shtoella, 537, 538, 539, 540, 542, 543, 544

Spirochaeta, 1067, 1069, 1070 Staphylococcus, 282 Streptococcus, 322, 323, 326, 327, 330, 333, 335, 339, 341, 343

Vibrio, 201, 205 Feces, Infant

Micrococcus, 257 Neisserio, 301 Pseudomonas, 198 Staphylococcus, 281

Fermenting and Fermented Materials

.lgare americana, sap Pseudomonas, 106

Alcohol infusions Bactersum, 675

Ale, bottled Acetobacter, 692 Beer, see Beer

Beet juice

Acetobacter, 183 Beeta

Bacellus, 656, 664, 752, 757 Bactersum, 675, 678, 686, 761 Lactobacillus, 357

Beverages Acetobacter, 181, 182

Bread dough Bueillus, 657, 661, 742

Bactersum, CS3

Lactobacellus, 357, 359, 361, 363 Cabbage, see Sauerkraut Cereal mash

Lactobarillus, 3/3 Corn mash

Clostridium, 781, 825 Lactobacellus, 357

Dates

Acetobacter, 181 Datgh

Bacillus, 742 Bactenum, 683

Ensilage, see Silage. Fermented milk drinks, see Dairy

Products, Fermented mill.

| Fermenting and Fermented Materials      | 4  |
|---|--|
| (continued)                             |  |
| Figs                                    | Lactobacillus, 357                               |
| 7                                       | , cucumber                                       |
| Acelobacter, 184                        | Lactobacillus, 357                               |
| Flax retting, see Retting, Flax         | -, tomato  |
| Fodder                                  | Lactobacillus, 357, 359                          |
| Bacillus, 750, 755                      | Plant juices                                     |
| Fruits                                  | Pseudomonas, 106                                 |
| Acetobacter, 181, 182, 183, 184         | Plant materials                                  |
| Ginger beer                             | Clostridium, 772                                 |
| Bacterium, 362                          | Lactobacillus, 317                               |
| Grain mash                              | Streptococcus, 325, 326, 327, 340 .              |
| Acetobacter, 182                        | Potato mash                                      |
| Bacillus, 824                           | Amylobacter, 813                                 |
| Granulobacter, 822, 824                 | Clostridium, 781, 808, 819                       |
| Lactobacillus, 356, 357, 359, 363       | Lactobacillus, 356, 357, 361                     |
| Hay                                     | Pulque   |
| Bacillus, 740                           | Pseudomonas, 106                                 |
| Hemp retting, see Retting, Hemp         | Streptococcus, 338                               |
| Hydrogen perovide solutions             | Sake   |
| Acetobacter, 189                        | Lactobacillus, 363                               |
| Infusions                               | Sauerkraut                                       |
| Bacillus, 672                           | Bacillus, 657, 750                               |
| Kenaf (Hebiscus) retting see Retting.   | Bacterium, 675                                   |
| Kenaf                                   | Lactobacillus, 357, 359                          |
| Kombucha from tea infusions             | Pseudomonas, 146                                 |
| Acetobacter, 189                        | Silage   |
| Malt                                    | Bacterium, 602                                   |
| Bacterium, 677, 678, 679, 688, 769, 761 | Clostridium, 785                                 |
| Malt beverages                          | Lactobacillus, 359                               |
| Acciobacter, 182                        | Propionibacterium, 376                           |
| Malt infusion                           | Streptococcus, 336                               |
| Micrococcus, 263                        | Slimy fermentation                               |
| Malt mash                               | Bacillus, 749                                    |
| Sarcina, 287                            | Soybean cake                                     |
|   | Bacillus, 757                                    |
| Mash, dried persimmon                   | Tobacco  |
| Acetobacter, 184                        | Bacterium, 674, 682, 685                         |
| Mash, spoiled                           | Urea   |
| Pediococcus, 249                        | Staphylococcus, 282                              |
| Mash, vegetable                         | TT   |
| Lactobacıllus, 356, 357, 359, 361       | Micrococcus, 238, 250, 260, 266, 267,            |
| Methane fermentation in swamps          | 269, 279, 280                                    |
| Sarcina, 287                            | Sarcina, 289, 293                                |
| Milk, Fermented see Dairy Products,     | Staphylococcus, 282                              |
| Fermented Milk                          | Vegetables                                       |
| Molasses                                | 101 189  |
| Clostridium, 781                        | Lactobacillus, 347, 350, 357, 359, 361           |
| Lactobacillus, 359, 363                 |  |
| Pickles                                 | Vinegar<br>Acelobacter, 181, 182, 183, 186, 187, |
| Bacillus, 648                           | 183  |
|   |  |

| Fermented Materials (continued)                       | Lela                                  |
|---|---------------------------------------|
| Vinegar (continued)                                   | Bacterium, 673                        |
| Bacillus, 756   | Mycobactersum, 883                    |
| Bactersum, 682  | Vibrio, 208                           |
| -, quick process                                      | Ceneral                               |
| Acetobacter, 187, 183                                 | Bacillus, 753                         |
| -, «ine   | Pseudomonas, 102, 109, 149            |
| Acetobacter, 187, 188                                 | —, blood                              |
| Wine, see Wine  | Rickettsia, 1007                      |
| Yeast, see Yeast                                      | Spirechaela, 1068                     |
| P1-1  | -, intestine                          |
| Fishes<br>African Mudfish, blood                      | Chitin-digesting bacteria, 632        |
|   | -, rectum                             |
| Spirochaeta, 1067<br>Anchovy piekle                   | Treponema, 1076                       |
| Pedrococcus, 250                                      | -, skin                               |
| Anchovy, salted                                       | Bacterium, 600, 612                   |
| Vibrio, 204   | Micrococcus, 246                      |
| Blenny, intestine                                     | Haddock 1995                          |
| Treponema, 1045                                       | Spirochaeta, 1065                     |
| Brochet   | -, elime                              |
| Burtonella, 1108                                      | Florobacterium, 438, 440, 441<br>Hake |
| Bullhead, Marine                                      | Flarobacterium, 439                   |
| Trepanema, 1074                                       | Habbut                                |
| Carp, pathogenic for                                  | Pseudomonas, 145                      |
| Bacterum, 642   | -, skin                               |
| Proteus, 491  | Flavobactersum, 429, 434, 437         |
| Pseudomonas, 102, 149                                 | Herring, salted                       |
| Mycobacterum, 883, 881                                | Sareina, 202                          |
| Catlish   | Kiblish                               |
| Serratia, 462   | Pseudomonas, 100                      |
| Codfish   | Lampres cel                           |
| -, feces  | Bartonella, 1108                      |
|   | Marine fishes                         |
| Achromobacter, 420, 423, 426, 427 Flacobactersun, 431 | Mycobactersum, 853                    |
| -, intestine  | Pacudomonas, 147                      |
| Achromobacter, 425                                    | Spirochaeta, 1007                     |
| Shrgella, 541   | Treponema, 1075                       |
| -, red salted   | Perch, erythrocytes                   |
| Micrococcus, 239                                      | Grahamella, 1110                      |
| Previoments, 110                                      | Politick<br>Spirochaeta 1003          |
| Sarring, 289  | Salmon, Blue black                    |
| -, din e  | Chordreeneeus, 1817                   |
| Achromolacter, 420, 423, 429, 427                     | Falmon eggs                           |
| # fored prierrum, 434, 436                            | Ackromedacter, 425, 672               |
| Cnulet  | dreased                               |
| Mycel-sitenum, ES1                                    | Pseudomonas, 700                      |
| Doefeh  | Ealted fishes                         |
| Flandacterium, 436                                    | Micrococcus, 200, 266, 268, 203       |
| -, shin e ani force                                   | Pseuderronce, 110                     |
| Achromolacter, 420                                    | Samra, 289                            |
| and the second second second                          | Vehrea, Tim                           |

Fishes (continued) Sardines, salted Vibrio, 204 - stomach Eubacterium, 367 Sea bass Mycobacterium, 884 Sergeant major Mycobacterium, 884 Shark, blood Borrelia, 1064 Skate, slime and feces Flavobacterium, 434, 439 Tench Bartonella, 1108 Trout Bacterium, 686 Whiting Microspironema, 1064 Fishes, Diseases of Carp - tumors Mycodacterium, 883, 884 -, red spots Bacterium, 642 Eela, diseased Bacterium, 673 Mucobacterium, 883 Vibrio, 203 General -, epidemic infection of fishes Bacillus, 751 Vabrio, 197 -... fresh water fishes Hemorrhagic septicema Pseudomonas, 102, 103 - skin lesions Pseudomonas, 102 - necrotic ulcers Rickettsia, 1097 - necrosis of the liver Chondrococcus, 1047 Mucobacterium, 884 Kilifish, skin lesions

Pseudonnonas, 109

Pseudomonas, 149

Pseudomonas, 109

--- tuberculosis

- - infected skin and muscle

Marine fishes

Mucobacterium, 884 Trout, furunculosis Racterium, 686 Salmon cegs Esoz lucius, 1108 436, 437 Tinca tenca, 1108 Trigla lucena, 1076 Urophycis tenuis, 439 Fomites Haurbrush Micrococcus, 253, 275

Hospital shirt

Serratia, 481

Achromobacier, 692 Pseudomonas, 700 Fishes, Scientific Names Abudefduf mauritii, 884 Acropoma japonicum, 636 Ameiuras melas, 462 Blennius pavo, 1075 Box boops, 1073 Centropristes strictus, 884 Clarics angolensis, 1067 Coelorhymchus sp., 636 Cottus bubalis, 1074 Cyprinus carpio, 491, 642, 884 Cuprinus sp., 102, 149 Fundulus parvininnes, 109 Gadus callarias, 420, 423, 425, 426, 427, 434, 436, 544 Gadus minutus, 1067 Gadus pollachius, 1069 Hippoglossus hippoglossus, 429, 434, Lepadogaster bimaculatus, 1075 Melanogrammus aeglefinus, 438, 440, Merlangus merlangus, 1064 Microponon undulatus, 884 Oncorrhynchus nerka 1047 Pelamys sarda, 1008 Perca fluviatilis, 1110 Petromyzon marinus, 1108 Physiculus japonicus, 636 Raja crinacea, 431, 439 Saccobranchus fossilis, 753 Squalus acanthias, 420, 427, 436 Tetraodon fahala, 1097 Trachurus japonicus, 694

-, macaroni, spoiled Fonds and Fondstuffs Anchovies, pickled Bacillus, 317 Micrococcus, 250 --- Deas Bocillus, 737, 756 Asparagus, boiled Bacillus, 742, 743 -. oumolin Bactersum, 759 Bacterium, 609 Bacon, tainted -, pumpkin, swells Vibrio, 702 Bacillus, 730, 731 Beans, salted, purple discoloration -, salmon, spoiled Pseudomenas, 109 Bacillus, 817 Beef extract - sammes Bacellus, 734 Serratia, 483 Beet juice, sugar -, spinach Leuconostoc, 313 Bacellus, 825 Blood sausare -, string beans, spoiled Clostridium, 788 Bacillus, 731, 748 Blutwurst -, tematoes Clostredium, 788 Bacellus, 750 Bread - vegetables, flat sours Bacellus, 661 Bacellus, 734 Bactersum, 680, 759 Catsup ~. 13e Lactobacillus, 359 Bacellus, 711, 750 \* Cheese, see Cheese -, slimy Codfish, reddened salt Bacillus, 711, 738 Bacellus, 657, 742 Bacterium, 760 Flarobacterium, 442 Butter, see Butter Preudomonas, 110 Candy Corn meal Bacellus, 756 Bacterium, 679 Canned beans Crab mest, musty odor Bacillus, 750 Achromobacter, 425 -, beets, blackened Cream, see Milk and Cream Bacillus, 733 Dairy Products, see Dairy Products -, blueberries Dates, commercially meked Bacillus, 735 Bacillus, 736 -, carrota Eggs, black rot Bacillus, 742 Proteus, 490 -, corn, spoiled -, cooked Bacellus, 731, 736 Racterium, 361 -, com, sulfur straker spoilage -, duck Clostridium, 803 Salmenella, 517 -, evaporated milk -, hen's Bacellus, 713, 738 Bacillus, 633, 651, 637, 639, 663, Pseudomonas, 103 672, 747, 730 - foods Pseudomonas, 147, 148, 149, 150, Bacillus, 713, 730, 731, 734, 736 179 Clostridium, 779, 797 -, musty -, goods, spoiled Achromobacter, 425 Bacillus, 730, 731, 731 Preudomosas, 148, 173 -, grade, smiled, non-seid -, rowdered

Falmonella, 510, 512, 513

Claridium, 755, 803

Salmonella, 519

Foods and Foodstuffs (conlinued) Plum preserves Fish conserves Bacillus, 753 Clostridium, 821 Pork -, herring, rusty Clostridium, 802 Pseudomonas, 110 Potato, cooked -, salted Bacillus, 664, 741, 748 Bacillus, 658 Rice, cooked in chicken broth Ristella, 576 Serratia, 484 -, semi-dried Salad dressing Flavobacterium, 694 Lactobacillus, 363 Food conserves Sausage Bacillus, 741 Bacillus, 749, 751, 752, 816 Gelatin, spoiled Clostridium, 778, 779 Bacillus, 756 Salmonella, 530 General Sugar, also see Sugar Serratia, 481, 482 Bacillus, 742, 745, 747 Grance, Snamsh dried Leuconostoc, 347, 348 Bacterium, 621 Micrococcus, 260 Ham, salted Spirillum, 217 Eubacterium, 367 -- bect -, sour Bacillus, 747 Clostridium, 784 -, factories, frog spawn fungus Horseradish, ground Leuconosice, 347, 348 Bacillus, 757 Spirillum, 217 Margarine Tomato juice Bacillus, 662, 667 Bacillus, 713 Bactersum, 681, 685, 689 Tomato products, speiled Meat Lactobacellus, 357, 359 Baclersum, 678 Truffles, cooked Micrococcus, 258, 272, 281 Bacillus, 757 Wiener skins Streptococcus, 338 Tetracoccus, 284 --- extract Bacillus, 648, 651, 740, 745, 746, 749 Wurst Micrococcus, 258, 272, 281 Bacterium, 678, 760 Micrococcus, 255, 267 Goats Streptococcus, 339 Cerebrospinal fluid ---, pies Salmonella, 531 Streptococcus, 338 Corneal or conjunctival discharges -, spailed Bacillus, 749 Colesiola, 1120 Milk, see Milk and Cream General Mincemeat, canned Salmonella, 506 Bacillus, 757 Goats, Diseases of Oranges Abortion Butylobacter, 825 Brucella, 561 Oysters Agalactia Inflabilis, 823 Anulomyces, 1292 Pickles Glanders Bacillus, 648, 754 Malleomyces, 555

Sea water gelatin colonies After 21 hours at 20°C, circular, about 1 5 mm in diameter or larger, margin slightly undulate, sunken due to the hegnaning of liquefaction, interior somewhat ronate, colonies surrounded by a halo of numerous small secondary colonies, circular and finely granular In crowded plates a large number of gas bubbles are formed Luminescent.

Sea water gelatin stab Rapid saccate inquefaction complete in 5 days at 22°C Abundant floceulent sediment

Sea water agar colonies: Mostly very large, 6 to 8 cm. in diameter in 24 hours, flat, highly iridescent, circular with undulate margin, or composed of narrow and close or wide filamentous growth Occasionally small colonies appear that are circular, with entire or slightly undulate margin, often producing irregular secondary growth, surface always smooth Luminescent.

Sea water agar slant. Growth abundant, spreading, grayishly viscous, homogeneous, iridescent, the medium becoming rapidly alkaline when inoculated at an initial pH of 7.0. With fish decoctions added to the medium, luminescence is much brighter and growth becomes brownish after several days.

Growth on autoclaved fish Abundant, smooth, glistening, yellowish, becoming dirty brown after several days. Mild putrefactive odor. Luminescence very halliant.

Sea water containing 0.2 per cent peptone: Abundant uniform turbuity, thin pelhele, sediment accumulating over a period of acveral days. Luminescence at surface only unless the tube is shaken Milk, with or without the addition of

28 per cent salt · No growth

Potato plugs resting on cotton saturated with sea water: Growth slight, somewhat spreading, slightly brownish. Luminous Indels to formed (Gora's method).

Indole is formed (Gore's method).
Nitrites are produced from nitrates.

Ammonia is produced in peptone media (Hansen method). Fived acid from glucose, fructose, mannose, galactose, sucrose, malose, mannitol, devtrin, glycogen, trehalose, cellobiose; slowly from salicin Nonfixed neid from melezitose, elight acid from sorbitol, divappearing in 24 hours. No acid from glycerol, vylose, arabinose, dulicitol, inositol, adonitol, erythritol, arabitol, lactose, rafilnose, rhamnose, fucose or alpha methyl glucoside.

Starch agar, Wide zone of hydrolysis
Hydrogen sulfide is produced (Zobell
and Fantham method).

Temperature relations Optimum 35° to 39°C Abundant growth at 22° to 25°C Optimum luminescence at 20° to 40°C.

Not pathogenic for white rats or amphipods.

Aerobic, facultative anaerobe

Source Isolated from a dead amphipod (Talorchestia sp.) at Woods Hole, Massachusetts

Habitat Sea nater.

63 Pseudomonas phosphorescens (Fischer) Bergey et al. (Bacillus phosphorescens Fischer, Zeitschn f. Hygs., 9, 1857, 38, Photobacterium indicum Beigenich, Arch Néerl d Sei Exactes, 23, 1859, 401; Bacterium phosphorescens Lelimann, Cent f Bakt, 5, 1859, 765; not Bacterium phosphorescens Fischer, Cent I Bakt, 3, 1888, 107, Bergey et al., Manual, 3rd ed., 1030, 177) From Greek phosphores, to bear or bring light.

See page 699 for additional synonyms Description taken from Fischer (loc. cit.)

Small, thick rods 2 to 3 times as long as wide, with rounded ends Motile. Stain lightly with amline dyes

Gelatin colonies After 36 hours, small, circular, gray-white, punctiform. Liquefaction Bluish to green phosphorescence in 4 to 5 days.

Blood serum: Gray-abite, slimy growth.

Potato. Thin white layer in 2 to 3 days.

| 1010                   | INDEX OF SOURC      | CES AND HABITATS                        |
|------------------------|---------------------|---|
| Hail                   |                     | Unmanded a c                            |
| Racillus, 711          |                     | Hemorrhagic septicemia                  |
| Micrococcus, 269, 2    | 70                  | Pasteurella, 548, 549                   |
|                        | .10                 | Hog cholera                             |
| Hogs                   |                     | Borrelia, 1063                          |
| General                |                     | Salmonella, 509, 531                    |
| Salmonella, 502, 5     | 01, 505, 507, 509,  | Infections                              |
| 510, 513, 514, 519,    | 521, 522, 525, 526, | Corynebacterium, 391                    |
| 527, 530               | , ,,                | Influenza                               |
| Genital organs         |                     | Hemophilus, 586                         |
| Brucella, 562          |                     | Listeriosis                             |
| Intestine              |                     | Listeria, 409                           |
| Bacillus, 753          |                     | Marseille's disease                     |
| Lymph glands           |                     | Bacillus, 662                           |
| Salmonella, 505, 5     | 10. 513. 514. 518.  | Measles                                 |
| 524, 528, 529          | ,,,,                | Streptococcus, 341                      |
| Liver, neerotic foci   |                     | Pyorrhoea                               |
| Sphaerophorus, 579     | 1                   | Leptothrix, 366                         |
| Ovary                  |                     | Septicemia                              |
| Bacillus, 757          |                     | Streptococcus, 317                      |
| Peritaneal fluid       |                     | Swine erysipelas                        |
| Bacillus, 666          |                     | Bacillus, 652                           |
| - 4001140, 000         |                     | Erysipelothrix, 411                     |
| Hogs, Diseases of      |                     | Swine fever                             |
| Abortion               |                     | Salmonella, 500                         |
| Brucella, 561, 562     |                     | Swine plague (Hog cholera)              |
| Abscesses              |                     | Micrococcus, 278                        |
| Corynebactersum, 35    | SS                  | Tuberculosis, avian                     |
| Vibrio, 206            |                     | Mycobacterium, 880, 881                 |
| Actinomycosis          |                     | Tuberculosis, bovine Mycobacterium, 879 |
| Actinomyces, 926       |                     | Ulcers, intestinal                      |
| Anthrax                |                     | Borrelia, 1063                          |
| Bacillus, 720          |                     |   |
| Blood in hog cholera   |                     | Horses                                  |
| Borrelia, 1063         |                     | Blood                                   |
| Bronehopneumonia       |                     | Nocardia, 897<br>Spirochaeta, 1066      |
| Bacillus, 657          |                     | Female genital tract                    |
| Calcareous deposits in | n museics           | Klebriella, 459                         |
| Actinomyces, 972       |                     | Streptococcus, 340                      |
| Caseous suppuration    |                     | Foctus                                  |
| Corynebacterium, 40    | 6                   | Streptococcus, 317                      |
| Conjunctivitis         |                     | General                                 |
| Rickettsia, 1120       |                     | Rickettsia, 1007                        |
| Cutaneous lesions      |                     | Salmonella, 518, 529                    |
| Spirochaeta, 1069      |                     | Intestine                               |
| Diarrhoca              |                     | Bacillus, 694                           |
| Bacillus, 826          |                     | Bifidobacterium, 369                    |
| Erysipelas             |                     | Streptococcus, 323, 327                 |
| Erysipelothrix, 411    |                     | Zuberella, 577                          |
| Heartwater-like diseas | se                  | Hock-joint (foals)                      |
| Rickettsia, 1097       |                     | Nocardia, 910                           |
|                        |                     |   |

Not pathogenic for Johne's disease Muco'acterium, 881

Goats. Diseases of Continued

\* . . . . . BY .

Heartwater

Cordria, 1991 Red blood cells, see Erythrocytes Toberculoria, avian Hemorrhagie septicemia Pastewella, 517 Myerbacterium, 880 Tuberculosis, piscine Kemtitis Mycobacterium, 883, 881 Colesido, 1119 Tuberculosis, anake Lesions Micobacterium, 885, 886 Socardia, 900 Tuberculous, turtle Orbitalmia, infectious Colemota, 1120 Mucdacterium, 880 Storcach Meuroppeumonia, barine Atterocoreus, 1272 Klebnella, 459 Tuberculwis, boyane Tunica sacinalis Micefacterium, 879 Hickettela, 1086, 1089 Guines Pirs Guines Pies, Diseases of 113cml Anthrax Richettria, 1886, 1088, 1089 Bacellut, 770 Smitchasta, 165, 1970 Brucellosia Srireichaudinnia, 1071 Brucella, 361, 362, 363 Sprenena, 1070 Cerucal adequire Chiliter Bactereider, 575 Backler, 815 Enimate Careum Boctenum, CS1 Metabacterium, 103 Ghaders Trepenena, 1075 Molicomers, 553, 450 Layel availed Henorelagie replicemb Harmolartonells, 1104, 1108 Fastewella, 519, 539, 531, 551, 551 Exit merter. Ferurian guines piga Infactions. Harmenstmills, 1100 Garlin, 281 Invalated with will Arcedia, 913 Barillas, 600, 817, 825, 826 Lieletinis Hermita, 522 Lucina 493 Enterior Lar Padendas Corneratia, Ich Sweencorew. 317 Helicerera, 10th Acrels mutdurell. Orn." at mia. 1774 Entrana, 108 Same. 35 Steln See Intestine and genital organs Malleonyres, 156 Friendle, be, 22 Section 19 14147 Prestament, 115 Speechasts, 193 Filts af present Ignight glands Semena. 31 1 20 "41, 6"2 Talerrale & Impro-M. torries Herdarenan, 574 またかけ れきべじ Turanting huran Non weeks March - cress + 175, 821 T x12 w, 6:1 Trionglanting men "Lyon by the rece I was a gra 1 60 2 50 Cls . 202 war star - ate Telerista to take rang

| Human Diseases (continued)          | , periuterine                         |
|-------------------------------------|---------------------------------------|
| Abscesses, cervical                 | Veittonella, 303                      |
| Actinomyces, 916                    | -, pulmonary                          |
| - chest                             | Actinomyces, 917                      |
| Nocardia, 920                       | -, rectal                             |
| -, dental                           | Eberthella, 534                       |
| Aerobacter, 456                     | -, skin                               |
| Bacillus, 650                       | Streptococcus, 333                    |
| -, ear                              | - subcutaneous                        |
| Corynebacterium, 402, 403           | Actinomyces, 916                      |
| -, facial                           | -, teeth                              |
| Bacterium, 607                      | Actinomyces, 917                      |
| -, foot                             | Aerobacier, 456                       |
| Aclinomyces, 973                    | Streptococcus, 320                    |
| - Iliac                             | -, thoracie                           |
| Cospora, 922                        | Clostridium, 821                      |
| -, inguinal                         | -, urinary tract                      |
| Nocardia, 976                       | Bacteroides, 566                      |
| -, intestinal                       | Clostridium, 806                      |
| Bacillus, 816                       | Acholuric jaundico                    |
|                                     | Streptomyces, 958, 962, 963, 965      |
| -, jaw<br>Actinomyces, 917          | Acne pustules                         |
|                                     | Micrococcus, 251, 259, 272            |
| Nocardia, 921                       | Corynebacterium, 387                  |
| Proactinomyces, 923                 | Actinomy cosis                        |
| Streptothriz, 924                   | Actinomyces, 927, 971.                |
| -, kidney                           | Cohnistreptothriz, 928                |
| Clostridium, 825                    | Discomptes, 918; 928                  |
| -, liver                            | Nocardia, 921, 975                    |
| Bacillus, 400, 660, 666             | Streptothrix, 923                     |
| Bacterium, 677                      | -, bone                               |
| Bacteroides, 567                    | Actinomyces, 917                      |
| Cohnistreptothrix, 975              | -, bronchial                          |
| Proteus, 490                        | Actinomyces, 916                      |
| Sphaerophorus, 579                  | -, lachrymal gland                    |
| Vibrio, 205                         | Actinomyces, 927, 979                 |
| -, lung                             | Nocardia, 919                         |
| Bacillus, 667                       | - lung                                |
| Ristella, 575<br>Sphaerophorus, 579 | Actinomyces, 916                      |
| -, mouth                            | Acute arthritis                       |
| Corynebacterium, 402                | Spirochaeta, 1007, 1070               |
| -, multiple                         | African relapsing fever               |
| Nocardio, 921                       | Borrelia, 1061                        |
|                                     | Akiyami (Japan)                       |
| , osseus<br>Diplococcus, 310        | Leptospira, 1973                      |
|                                     | Alonecia arcata                       |
| , palm<br>Actinomyces, 971          | Microcrecus, 239                      |
| -, parotid                          | Alicolar pyorrhea, see Pyorrhes alres |
| Streptomyces, 963                   | laris                                 |
| -, perianal                         | Anal pus pocket                       |
| Sphaerophorus, USO                  | Corynebacterium, 400                  |
|                                     |                                       |

| Horses (continued)                      | Glanders                           |
|---|------------------------------------|
| Large intestine                         | Malleomyces, 551, 555              |
| Bacillus, 612, 747, 749, 755, 813, 814, | Hemorrhagic septicemia             |
| 815, 817, 818, 826, 827                 | Pasteurella, 549, 550, 551, 553    |
| Clostridium, 783, 799                   | Infections, genitourinary system   |
| Eubacierium, 368                        | Klebsiella, 459                    |
| Gaffkya, 281                            | Influenza                          |
| Hiblerillus, 822                        | Streptococcus, 340                 |
| Inflabilis, 823                         | Joint all of feels                 |
| Microcoreus, 201                        | Shigella, 512                      |
| Liver                                   | Lymphangitis, ulcerative           |
| Malleomyces, 555                        | Corynebacterium, 389               |
| Salmonella, 507                         | Nasal secretion in glanders        |
| Nasal passages                          | Bacterium, 683                     |
| Corynebacterium, 385                    | Paeumonia                          |
| Not pathogenic for Avian tuberculosis   | Bacterium, 684                     |
| Mycobacterium, 880                      | Streptococcus, 339                 |
| l'neumonia                              | -, infectious of foals             |
| Corynethrix, 407                        | Corynebacterium, 391               |
| Respiratory tract                       | Purulent infections, urinary tract |
| Streptococcus, 318, 337                 | Corynebacterium, 389               |
| Saliva                                  | Pus, respiratory tract             |
| Nocardia, 975                           | Streptococcua, 318                 |
| Skin                                    | Ringaorm                           |
| Corynethrix, 406                        | Actinomyces, 910                   |
| Hpleen                                  | Stomatitis                         |
| Malleomyces, 555                        | Treponema, 1074                    |
| Threat                                  | Strangles                          |
| Streptococeus, 315                      | Streptococcus, 318                 |
| Urine                                   | Ulcerative lesions                 |
| Bactersum, G12                          | Corynebactersum, 380               |
| Pedrococcus, 230                        | Wounds                             |
| Narcina, 201                            | Corynebacterium, 385               |
| Horses, Diseases of                     | Human Diseases                     |
| Shortion                                | Absertes                           |
| Brucella, 561, 562                      | Alcohgenes, 413                    |
| Salmonella, 106                         | Micrococcus, 212, 211              |

Streptoroccus, 336 Almereus on same Varardia, 933 Acne pustules Bacillus, 658 Corynebacterium, 401

Betryomyreas Berrery, 23 Undanetritie

Streptorocus, 317 Cangrerous derrustitis Splanophorus, 377

Surplanary, 311

General

Proteur, 458, 490

Pseudommas, S3 Salmonella, Mi Streptoroccus, 333 Veillonella, 200

- abdominal Bacillus, 815 - alreolar

Bacterium, 678

-, lesin Barollus, CA, CA, SA, 815 Capsularss, 577

Nocardia, 897

Colitis, ulcerative

Micrococcus, 696

Human Diseases (continued) Columbensis fever Carate Salmonella, 531 Treponema, 1073 Conjunctival catarrh Carcinoma, ulcerating Bacterium, 677 Spirochaeta, 1074 Conjunctivitis Carrion's disease Actinomyces, 916, 968, 969 Bartonella, 1101 Bacillus, 741 Catarrh Bacterium, 759 Micrococcus, 258 Hemophilus, 585 Neisseria, 298 Micrococcobacillus, 690 Staphylococcus, 282 Mimeae, 595 ~. scute Neisseria, 201 Staphylococcus, 282 Streptothrix, 924 -, acute epidemic -. angular Coryncbacterium, 401 Moraxella, 691, 592 Central and South African relapsing - granular fever Bacillus, 589 Borrelia, 1060 Noquehia, 503 Cerebrospinal meningitis, epidemic - inclusion Neisseria, 297, 302 Chlamydosoon, 1115 Chancroid -, neonatal Hemophilus, 587 Chlomydozoon, 1115 Chancroidal ulcers -, swimming pool Streptococcus, 341 Chlomydozoon, 1115 Chicken pox pustules Cornes, infected Streptococcus, 315 Bocterium, 679, 685 Choleocystitis Corneal ulcerations Ristella, 577 Morazella, 591, 592 Cholera Cracked beels Bacillus, 659, 665, 667, 738 Actinomyces, 916 Bacterium, 687 Cvstitis Bacillus, 650, 653, 665, 666, 668, 741, Escherichia, 447 Spirillum, 217 Vibrio, 194, 204, 205, 206 Bocterium, 530, 676 Escherichia, 447 Cholera infantum Micrococcus, 248 Alcaligenes, 415 Proteus, 490 Vibrio, 198 Shigella, 543 Cholera like disease Staphylococcus, 282 Vibrio, 205, 206 Streptobacillus, 590 Cholera nostras Streptococcus, 339, 343, 314, 345 Vibrio, 198 -, fetid Chromidrosis of axilla Clostridium, 825 Micrococcus, 256 Chronic endometritis -, pus Actinomyces, 918, 974 Vibrio, 198 Dacryocystitis Climatic bubo Cohnistreptothrix, 975 Miyagawanella, 1116 Dengue Colitis Leptospira, 1078, 1079 Shigella, 543 Dental caries -

Acidobactersum, 361

| Human Diseases (continued)             | Beriberi             |
|--|----------------------|
| Anemia                                 | Bacillus, 649, 738   |
| Haemobartonella, 1104                  | Micrococcus, 253     |
| -, pernicious                          | Black water fever    |
| Salmonella, 522                        | Leptospira, 1078, 1  |
|  |                      |
| Angina                                 | Blue pus             |
| Streptobacillus, 580                   | Pseudamonas, 89      |
| , Ludwig's                             | Boils                |
| Streptococcus, 329                     | Micrococcus, 242, 2  |
| Vincent's                              | Botulism             |
| Barrelia, 1063                         | Bacillus, 814        |
| Anginous exudate                       | Clostridium, 779     |
| Actinomyces, 917                       | Boutonneuse fever    |
| Anorectal inflammation                 | Rickettsia, 1089, 10 |
| Miyagawanella, 1116                    | Bright's disease     |
| Anthrax                                | Streptococcus, 338   |
| Bacillus, 720                          | Bronchiectasis       |
| Micrococcus, 203                       | Capsularis, 577      |
| Proteus, 601                           | Streptococcus, 332   |
| Aphthous ulcers of gingival and bureal | Bronchitis           |
| mucoza                                 | Actinomyces, 973     |
| Veillonella, 304                       | Bacillus, 500        |
| Appendicitis                           | Cladothriz, 974      |
| Bacellus, 752, 814, 817, 818, 826, 827 | Nocardia, 921        |
| Bacteroides, 800, 867                  | Spirochaeta, 1065    |
| Clastrideum, 773, 776                  | Vibrio, 206          |
| Corynebacterium, 403                   |                      |
| Diplococcus, 309, 310                  | Zuberella, 578       |
| Fusoharierum, 182                      | , chronic            |
| Cospora, 922                           | Ristella, 570        |
| Ramibactersum, 369                     | -, fetid             |
| Rratella, 575                          | Barillus, 613        |
| Streptococcus, 329, 330, 331, 332, 333 | -, putrid            |
| Veillonella, 302, 304                  | Bacellus, 740        |
| -, gangrenous                          | Bronchopleuropneur   |
| Sphaerophorus, 570                     | Nocardia, 921        |
| Arthritis                              | Bronchopneumonia     |
| Bacterium, 674                         | Bacterium, 600       |
| Diplococcus, 307                       | Brucellosis          |
| Microeoccus, 250                       | Brucella, 561, 562   |
| Neisseria, 201                         | Bulsocs              |
| Streptobacillus, 580                   | Pasteurella, 549, 53 |
| -, acute                               | Bubonic plague       |
| Spirochasta, 1009, 1070                | Nocardia, 220        |
| Ascitic fluid, old                     | Bullis fever         |
| Sarcina, 293                           | Richettina, 1008     |
| Balantis                               | Cancer of the etomac |
| Spirockaria, 1005                      | Barillus, 740, 745   |
| Banti's disease                        | Cancerous tissue     |
| Streptomyree, 900                      | Micrococcus, 208     |
| Bartonelkeur                           |                      |
| Bactonella, 1101                       | Cancerous ulcers     |
| armetering book                        | Speechorta, 1074     |
|  |                      |

1079 , 268 1008 s 2 einomu 2 551 ach

Human Diseases (continued) European relapsing fever

Borrelia, 1060 European typhus Rickettsia, 1085

Exanthematous typhus

Rickettsia, 1085 Spirochaeta, 1067

Febrile illness

Rickellsia, 1008 Felons with red pus

Serratia, 484 Fever, see

Blackwater fever

Boutonneuse fever Bullis fever

Columbensis fever Endemic typhus

Enteric fever

Eruptive fever European typhus

Dutch East Indies fever

Five day fever Kenya typhus

Malta fever Marseilles fever

Mediterranean fever Mexican typhus

Mianeh fever (Persia)

Murine typhus Oroya fever

Paratyphoid Parenteric fever

Parrot fever Postnatal fever

Pretibial fever Puerperal fever

Q (Queensland) fever

Rat bite fever Recurrent fever

Rocky Mountain spotted fever São Paulo exanthemic fever, Brazil

Scarlet fever Scrub typhus

Seven day fever, Japan Shin bone fever

South African tick bite fever South American relapsing fever Spanish relapsing fever

Spotted fever, Minas Geraes Swamp fever, Europe

Tobia fever, Colombia

Trench fever

Typhoid fever Typhus fever

Western relapsing fever

Wolhynian fever Yellow fever

Five-day fever Rickettsia, 1005

Food poisoning

Bacillus, 665, 669, 670, 672

Salmonella, 503, 504, 510, 511, 513, 514, 517, 519, 521, 523, 528, 529, 530, 531

Furuncles

Micrococcus, 242

Gangrene Bacillus, 814

Clostridium, 819 -, buccomaxillary

Leptospira, 1078 Gangrene, gas, see Gas gangrene

- Jung

Bacterium, 680 Catenabacterium, 365

Streptococcus, 329, 330, 331, 332, 343 --. mouth

Streptococcus, 342 -- pulmonary

Bacillus, 827

Bacteroides, 506, 567 Veillanella, 303, 304

- putrefactive

Streptococcus, 329 - senile

Bacillus, 757 Gangrenous foot

Ascococcus, 250 Gangrenous lung exudate

Bacillus, 613

Gangrenous phlegmoa, mouth Spirochaeta, 1070

Gangrenous pulp, tooth Bacillus, 666, 745

Gangrenous wounds

Bacillus, 815, 825, 826, 827 Clostridium, 792, 812, 825 Martellillus, 823

Reglillus, 823 Robertsonillus, 823

Gas gangrene Bacillus, 753, 813, 816, 817, 824, 823

Empyema Human Diseases (continued) Diplococcus, 307 Dental earles (continued) Lentothrix, 366 Bacillus, 252, 741, 745 Lactobacillus, 363 - nurulent Capsulans, 577 Lentotrichia. 363 Endemic typhus Streptococcus, 320, 339, 311, 312 Libra m Rickettina, 10% Lindocarditie Dermatoris Cohnsetreptothriz, 918, 975 Actinomyces, 917 Bacellus, 651 Nocardia, 921 Dabetes Cillobacterium, 303 Corunebactersum, 401, 403 Bacillus, 813 Diplococcus, 307 Distribuca Hemonhilus, 589 Hacellus, 650, 660, 813, 818 Staphylococcus, 282 Clarterdrum, 520 Streptococcus, 321, 326, 327, 339, 313, 314 Proteur, 188 Vibrio, 206 Restella, 570 Nalmonella, 105, 511, 515, 519, 522, --. reptic Bacterium, 300 521. 52N -. ulcerative Shipella, 538, 539, 549 Micrococcus, 274 Diphthens Stanhyloroccus, 202 Horrillus, 752 Enterio fever Corynchactersum, 285, 1(1), 491, 497 Salmenella, 501, 502, 503, 505, 507, Mierreterus, 200 500, 511, 513, 511, 517, 518, 519. Streptoroccus, 337 523, 521, 523, 506, 527, 528, 529 Dutch last Inders fever Lepimenta, 1074 1.nterstis Hymnteric ententia, Ceylon According, 520 Serano, 22 Spenilum, 215 Streptororeus, 339, 311 in matera Bacterium, 053 Leantier lever Ricketting, 1889 Plettella, 431 Salmonella, 231 Lumph Shipilla, 536, 537, 539, 539, 549, 542, Streptoreces, 315, 315, 311 513, 511 Les marks, grangeracius Englella, 573 1 stra, 24 -, Friidun l ryange kad Barillar, 48 Frangelains, 411 1 crena Levillena interiore Macrecoreus, 264 Bariller, Gil, Gil, GA learning Cit, CA, Con I rythena multiforme Strepted acrillian, 300 Microres, 25, 20, 23 l'hythena nelson . - 10 1710 . Rundler, 742 Printmines, 184 Latienaufticakia He lattans Burnery, 23 I willy 150 1 sy than "a I may to provide Innoverse, 979 Lander, ogs Newst. 4, 121 In it terrat de l'ire Inthorwea fim sdram, NI

Mayaranerella, 1110

| Human Diseases (continued)             | Louisiana pneumoma            |
|--|-------------------------------|
| Influenza                              | Miyagawanella, 1119           |
| Dialister, 595                         | Lung diseases                 |
| Hemophilus, 585, 586                   | Actinomyces, 970              |
| Micrococcus, 264, 272, 277             | Mycobacterium, 878            |
| Sarcina, 294                           | Nocardia, 899                 |
| Streptococcus, 340, 341, 342, 314, 345 | - exudate                     |
| -, nasal washings                      | Sarcina, 290                  |
| Veillonella, 303                       | Lupus                         |
| Intestinal intoxication                | Bacillus, 661                 |
| Micrococcus, 247                       | Lymphogranuloma inguinals     |
| Intestinal ulcer                       | Miyagawanella, 1116           |
| Bacterium, 677                         | Lymphogranuloma venereun      |
| Jaundice, acholuric                    | Miyagawanella, 1116           |
| Streptomyces, 958, 962, 963, 965       | Madura foot                   |
| Spiroschaudinnia, 1071                 | Nocardia, 909, 915            |
| infectious                             | Streptothrix, 924             |
| Leptospira, 1077                       | Malignant edems               |
| Pseudomonas, 90                        | Bacillus, 826                 |
| Kenya typhus                           | Profeus, 691                  |
| Richettara, 1080                       | Malignant tumor               |
| Keratitis                              | Spirochaeta, 1067             |
| Actinomyces, 915, 917                  | · Malta fever                 |
| Discomyces, 018                        | Brucella, 561                 |
| Kolpohyperplasia cystica               | Marseilles fever              |
| Bacillus, 826                          | Rickettsia, 1089              |
| Leproma                                | Mastitis                      |
| Actinomyces, 016                       | Tetracoccus, 284              |
| Leprosy                                | Mastoiditis                   |
| Mycobacterium, 882, 887                | Bacteroides, 566              |
| Leprosy-like lesions                   | Diplococcus, 397              |
| Mycobacterium, 882                     | Staphylococcus, 262           |
| Leprous lesions                        | Measles                       |
| Mycobacterium, 882                     | Diplococcus, 311              |
| Leukemia, lymphatic                    | Salmonella, 51                |
| Bacterium, 689                         | Streptococcus, 341            |
| Spirochaeta, 1068                      | Veillonella, 303, 374         |
| Lichen planus                          | Mediterranean fe              |
| Ristella, 576                          | Rickettsia, 1089              |
|  | Melioidosis                   |
| Lichen ruber                           | Malleomyces, 556              |
| Bacillus, 660                          | Meningelia                    |
| Lingua nigra                           | Bacillus, 662                 |
| Oospora, 922                           | Cillobacterium, 369           |
| Lasteriosis                            | Corynebacterium, 403          |
| Lasteria 409                           | Diplococcus, 307              |
| Liver abscesses, see Abscesses, hver   | Lactobacillus, 361            |
| laver, acute yellow atrophy            | Valleamuces, 556              |
| Bactllus, 659                          | Neisseria, 297, 299, 301, 302 |
| -, infected                            | Salmonella, 505, 522, 527     |
| Micrococcus, 272                       |                               |

| Human Diseases (continued)            | Hemorrhagic septicemia                     |
|---------------------------------------|--|
| Gas gangrane (con'inued)              | Bacterium, 677                             |
| Clostredium, 773, 778, 782, 783, 751, | Pastrurella, 240                           |
| 788, 791, 791, 796, 821               | Hodgkin's disease, lymph glands            |
| Martellillus, 823                     | Corpnelacterium, 402, 403, 401             |
| Streptococcus, IV                     | Illinois virus                             |
| Gascous edema                         | Meyagawanella, 1119                        |
| Closterdium, 825                      | Indus religiong fever                      |
| Gascous phlegmons                     | Borrelia, 1062                             |
| Bacellus, 826                         | Infant diarrhoes                           |
| Gastrie derangement                   | Ptreptocoecus, 339                         |
| Barillus, 739, 814                    | Infantiliem                                |
| Clastroenteritis                      | Hacelluce, 746                             |
| Hacillus, Tal                         | Infections                                 |
| Paraenidactrum, 400                   | Actinomices, 973                           |
| Proteus, 144, 490                     | Corynebactersurs, 634                      |
| Salmmella, 301, 505, 576, 507, 500,   | Semena, 20                                 |
| 511, 512, 513, 514, 515, 517, 518,    | Accentic, 529, 201, 207, 212               |
| 319, 521, 522, 523, 524, 525, 528,    | Proteut, 491                               |
| 527, 572, 701                         | Salmonella, 131                            |
| Generalites                           | Sphoerephorus, 579                         |
| Norardia, 937                         | Streptorcecus, 316, 321, 340, 312, 313,    |
| (likayami (Jipan)                     | 311, 315                                   |
| Legiorpira, 1977                      | Steeptometer, 961, 962, 963, 961, 965, 967 |
| Gingisitis                            | -, seme, legs and chest                    |
| Fusification, 613                     | Actinomyces, 917                           |
| Ghn lers                              | -, Unider                                  |
| Matternyeer, Illi                     | Actinomyces, 918                           |
| Glan lets like disease                | -, gradouritary tract                      |
| Noticempers, SSA                      | Luctenetra, 447, 432                       |
| Charitie                              | -, log                                     |
| Microreces, UG                        | Bacteriar, 401                             |
| Gitestlera                            | m, outer est                               |
| Antoma, 76                            | Varardia, 919                              |
| Microcorest, 217, 276                 | tempol                                     |
| Ceranal Ca                            | Claimin, 523                               |
| Actinomyces, 517                      | ~. junejumi                                |
| tirensky a segucido                   | det. 500 yes, 200                          |
| Dimmercia, 150                        | licetermier, 97                            |
| Alch (54, 47)                         | ( alteraty                                 |
| Sycarbours, 1885                      | Acrearyes, 116                             |
| Grandon talemen                       | 4115ATT                                    |
| Constructe numbers                    | Es terado, tri                             |
| tuar > y firsa +a                     | . Lie Tus                                  |
| Michael, 25                           | Let the fix                                |
| Alamana arabina Jajah                 | Isfar et apper ly                          |
| Engrape 4, 2 Ch                       | Micror wout, f. r.                         |
| Here relay refer to a                 | Inflammations, genitron, carry trans       |
| 1- /240,531                           | Plien, trans, 1115                         |
| Here on spranghting                   | Irterat y stationer                        |
| to reaso, this                        | L + 2" +, 235                              |
|                                       |  |

Cooked fish: Abundant growth. Entire surface covered with a gray-white, slimy growth. Bluish-white phosphorescence.

Alkaline hroth: Slight turbidity in 24 hours. Pellicle in 3 days.

Acid broth: No turbidity. No phos-

Milk: No growth.

No gas formed.

No gas formed.

Not pathogenic for lahoratory nnimals.

Aerobic.

Optimum temperature 20° to 30°C. Source: From sen water of the West Indies.

Habitat, Sea water.

63. Pseudomonas plerantonii (Zirpolo) Bergey et al. (Alicrococcus pierantonii Zirpolo, Boll. del. Societa del Natural. in Napoli, 31, 1918, 75; Cocco-bacillus pierantonii Meissnor, Cont. f. Bukt., 11 Abt., 67, 1920, 204; Bergey et al., Manual, 3rd ed., 1930, 176) Named for Pierantoni, an Italian.

Oval rods: 0.8 hy 1.0 to 20 microns. Polymorphic rods, sometimes vacuolated. Motile. Gram-negative.

Gelatin colonies Circular, luminous. Gelatin stab. Not llouefied.

Sepia agar colonies Circular, white, convex, smooth, serrate edge. Intenso greenish luminescence.

Egg-glycerol agar slant: Yellowishgreen, luminous streak.

Broth: Turbid.

Indole not formed.

Acid from glucose and maltose, some strains also produce acid from lactose and sucrose.

Best growth in alkaline media.

Aerobic.

Optimum temperature 33°C.

Source Isolated from the photogenic organ of the cepbalopod Rondeletia minor.

\*65. Pseudomonas martynlae (Elliott) Stapp. (Bacterium martyniae Elliott, Jour. Agr. Res., 29, 1924, 490; Stapp, in Sorauer, Handbuch der Pflanzenkr., 2, 5 Auf., 1928, 278; Phytomonas martyniae Bergey et nl., Manual, 3rd ed., 1930, 262.) From M. L. Martynia, a generic name.

Rods: 0.50 to 1.63 microns. Capsules. Chains. Motile with one to several hipolar flagella. Gram-negative.

Green fluorescent pigment produced. Gelatin: Liquefied.

Beef agar colonies: White, round,

smooth, glistening, raised.

Broth: Clouding in bands. Thin pelli-

ele. Small crystals.

Milk: Soft acid curd with peptonization.

Nitrites produced from nitrates after 2 weeks.

Indole not produced.

Hydrogen sulfide production slight.
Acid but not gas from glucoso, galactoso, nrabinose and sucrose. No acid from rhamnose, lactose, maltose, raffinose, mannitol and glycerol.

Starch hydrolysis none or feehle.

Optimum temperaturo 26°C. Maximum 37°C. Minimum 1.5°C.
Optimum pH 6.0 to 6.7. pH range 5.4

Optimum pH 6.0 to 6.7. pH range 5.4 to 8.9.

Aerobic.

Source: Isolated from diseased leaves of the unicorn plant from Kansas.

Habitat: Pathogenie on Marlynia louisiana.

66. Pseudomonas strlafaciens (Elliott) Burkholder. (Bacierium striafaciens Elliott, Jour. Agr. Res., 55, 1927, 823; Phytomonas striafaciens Bergey et al., Manual, 3rd ed., 1930, 203; Burkholder, Phytopath., 52, 1942, 601.) From L. stria, stripe; faciens, making,

<sup>\*</sup> The section covering the pseudomonads that cause plant diseases has been revised by Prof. Walter H. Burkholder, Cornell Univ., Itbaca, New York, April, 1943.

| Human Diseases (continued)     | Osteomyelitis                     |
|--------------------------------|-----------------------------------|
| meningitis (continued)         | Bacillus, 661                     |
| Streptoroccus, 311             | Restella, 575                     |
| - cerebroinaple fluid          | Streptococcus, 330                |
| Neisseeia, 299                 | Osteophlegmon, maxillary bone     |
| - purulent                     | Pseudomonas, 701                  |
| Bacterium, 676, 682            | Otitis                            |
| Hemophilus, 355                | Hacteroides, 567                  |
| Sphartophorus, 579, 580        | Cellodacterium, 319               |
| Meningopheumonitis             | Sphaerocillus, 580                |
| Vegagarantila, 1117            | Sphaerophorus, 579                |
| Mexican typhus                 | Otitis media                      |
| Bickettera, 1985               | Bacillus, 666                     |
| Mianch lever, Person           | Corynebactersum, 402              |
| Spirerhaeta, 100               | Inplococcus, 307                  |
| Mobile car infections          | Otena                             |
| Stankstororeus, 252            | Bacellus, 658                     |
| Mite bite lesons (evetar)      | Corynebacterium, 407              |
| Ricketting, 1991               | Klebnella, 457                    |
| Moneen relations fever         | Pseudomanas, 95                   |
| Spiritaria, 1967               | Salmmella, 371                    |
| Multiple sclerosis             | Sarma, 272                        |
| Sperochaeta, 10%               | Steeptoroccus, 340                |
| Murine typhus                  | -, arcitions                      |
| Rieletting, 1987               | Microcorcus, 206                  |
| Macetoria                      | Parataphoni                       |
| Actinomyres, 916, 914          | Salmonello, 1011, 1017, 130, 1312 |
| Thecomyres, 918, 919           | Parentene fever                   |
| Secretia, 101, 107, 219, 221   | Herthella, 531                    |
| Prantinomyres, 8.5             | Paretitie epidemica               |
| Street compress, 810, 663, 566 | Micrococcus, 270                  |
| Streptwins, 921                | Parrol feet                       |
| Marcone funguiles              | Misagaranella, 1117               |
| Streptmoreus, 343              | Parteurellman                     |
| Marine, pulmouses              | Parteurella, 123                  |
| timp ma, 5023                  | Pelligra                          |
| Secreta                        | Berillus, 748                     |
| (Tortholium, 811, 821          | Microroccus, 281                  |
| tican Advacter, 822            | Personmar, 11%                    |
| , in transport                 | Per plagus acutus, bullis-        |
| Portlet, Car                   | Mercerore s. 270                  |
| Sept title                     |                                   |
| flars' we REA                  | Perry light entagens, Indha-      |
| Fateriam, 602, 760             | Marco areas, 270, 271             |
| Restulies gently morning       | Ferry fague ton natural, Eullien  |
| From two, 66                   | Marrie William, 271               |
| Charles and State of Lotted    | Perimidal exclate                 |
| 17mjnr4, 722                   | Larder, 115                       |
| the thing                      | Personality of                    |
| Magazarara la MM               | Anglaines at 12                   |
| the on faces                   | Anne de to                        |

Human Diseases (conlinued) -- cafarrhal Peritoncal evudate Baclerium, 687 Sphaerophorus, 579 - louisiana Peritonitis Miyagau ancila, 1119 Clostridium, 820 -, septic Ramibacterium, 369 Bacterium, 684 Streptococcus, 307 -, virus Pernicious anemia Miyagawanella, 1119 Salmonella, 522 Pacumonie plague Pertussis Pasteurella, 549 Bacterium, 590 Pneumonitis Hemophilus, 586, 589 Miyagawanella, 1119 Petechiae in skin Polyarthritis. Neisseria, 207 Corynebacterium, 402 Phagadenous ulcer Postnatal fever Borrelia, 1061 Corynebacterium, 405 Pharyngitis Postpoliomyelitic paralysis Zuberella, 578 Verlionella, 304 Phlegmon, perinephritic Pretibial fever Streptococcus, 329 Rickettsia, 1008 Phthasis Prostatitis. Bacterium, 687 Actinomyces, 918, 974 Sarcina, 293 Pseudoactinomycosis Pink eve Actinomyces, 916 Bacellus, 589 Nocardia, 921 Pseudodysentery Treponema, 1073 Shigella, 538 Pityrusis Pseudomycosis Discomyces, 919 Mierococcus, 696 Plaguo Pseudotuberculosis, pulmonary Pasteurella, 549 Nocardia, 919 Pleurisy Paittacosis Streptococcus, 329, 332 Rickettsia, 1095 - purulent Miyagawanella, 1117 Eubacterium, 367 Proriasia Pasteurella, 554 Nocardia, 321 Risicila, 577 Puerperal fever Streptobacillus, 581 Bacillus, 580 Pleuronneumonia Micrococcus, 216 Diplococcus, 310 Streptococcus, 318, 329, 331 Pleuropaeumonia-like discase, 1293 Puerperal septicemia Pacumonia Clostridium, 821 Actinomuces, 973 Staphylococcus, 701 Bacillus, 647, 665, 703, 918 Pulmonary mycosis Brucella, 563 Oospora, 923 Dintococcus, 307 Pulmonary cosporosis Klebstella, 458 Qospora, 922 Salmonella, 518 Pulmonary tuberculosis Streptococcus, 341 Actinomyces, 917 Pacumonia, atypical

Mivagauanella, 1117

Mycobacterium, 878, 897

| Human Diseases (continued)               | Pyemia                |
|--|-----------------------|
| Pulmonary tuberculosis (continued)       | Bacterium, 685        |
| Oospora, 923                             | Sphaerophorus, 580    |
| Streptococcus, 343                       | Pyorrhoea             |
| Purulent pleural fluid                   | Streptothrix, 923     |
| Salmonella, 577                          | Pyorrhoea alveolaria  |
| Purulent urethral discharge              | Mierococcus, 262      |
| Spirochaeta, 1074                        | Spirochaeta, 1069     |
| Pus                                      | Treponema, 1072       |
| Actinamyees, 916, 927, 971, 974          | Veillonella, 303, 304 |
| Bacillus, 659, 665, 737, 826             | Pyrexia               |
| Bacterium, 678, 685                      | Salmonella, 519       |
| Clostridium, 806                         | Q (Queensland) fever  |
| Corynebacterium, 403, 406                | Coxiella, 1093        |
| Leptospira, 1078                         | Rabies                |
| Micrococcus, 241, 242, 243, 251, 256,    |                       |
| 275                                      | Streptococcus, 340    |
| Nocardia, 921                            | Rag picker's disease  |
| Oospora, 922                             | Proteus, 691          |
| Proactinomyces, 923                      | Rat bite fever        |
| Sarcina, 293                             | Actinomyces, 972, 97  |
| Spirochaeta, 1060                        | Spirillum, 215        |
| Staphylococcus, 282                      | Streptothrix, 924     |
| Streptococcus, 316, 321, 326, 341        | Rectal ulcer          |
|  | Eubactersum, 367      |
| Streptomyces, 963                        | Recurrent fever       |
| Pus, anal pocket<br>Corynebacterium, 406 | Spirochaeta, 1067     |
| —, blue                                  | Red perspiration      |
| Pseudomonas, 89                          | Micrococcus, 263      |
| -, cars of scarlet fever patients        | Relapsing fever       |
| Corynebacterium, 402, 403                | Borrelia, 1060, 1061  |
| -, gonorrhoeal                           | Spirochaeta, 1065, 1  |
| Micrococcus, 276                         | , African             |
| Neisseria, 240                           | Borrelia, 1061        |
| -, joints                                | , Central and So      |
| Hemophilus, 585                          | Borrelia, 1060        |
| Nesseria, 296, 297                       | European              |
| -, peritoneal                            | Borrelia, 1000        |
| Streptococcus, 337                       | Indian                |
| -, pyelitis calculosa                    | Borrelia, 1062        |
| Vibrio, 206                              | Moroccan              |
| -, stinking                              | Spirochaeta, 1067     |
| Bacillue, 583                            | South American        |
| , telanus                                | Barrelia, 1064        |
| Bacillus, 649                            | — — Spanish           |
| , teeth                                  | Spirochaeta, 1067     |
| Chromobacterium, 231                     | — 🛶 Western           |
| Pvelitis calculosa                       | Borrelia, 1064        |
| Spirillum, 217                           | Rheumatism            |
| Vibrio, 206                              | Streptococcus 313     |
| De alone attern                          |                       |

Pyelocy stitus

Klebnella, 438

74 1, 1062, 1063, 1064 1066, 1069, 1070 outh Africa Streptococcus 313 Attinomyces, 927

-, neute

1

1330 Human Diseases (continued) Rheumatism, articular Micrococcus, 275 Spirochaeta, 1070 Rhinitis Zuberella, 578 -, chronic Salmonella, 531 Rhinopharyngitis Treponema, 1076 Rhinoscleroma Klebsiella, 459 Rickettsialpox Rickettsia, 1002 Rocky Mountain spotted fever Rickettsia, 1088, 1089, 1098 St. Vitis dance Nocardia, 975 São Paulo exanthemic fever Rickettsia, 1088 Sarcoma Bacillus, 744 Scarlatina Bacillus, 656 Corynebacterium, 406 Nocardia, 919 Scarlet fever Bacillus, 649, 668 Micrococcus, 255, 275 Neisseria, 301 Streptococcus, 315, 343 Veillonella, 303, 304 Scrub typhus Rickettsia, 1091 Scurvy Bacterium, 678 Seborrhoic eczenia Pseudomonas, 148 Septicemia Bacıllus, 738 Bacterium, 553, 674, 686 Bacteroides, 566, 567 Chromobacterium, 232, 233 Clostridium, 796, 821, 826 Miyagawanella, 1119 Streptococcus, 316 Seven day fever, Japan Leptospira, 1077

Shin hone fever

Rickettsia, 1005

Skin abscess Streptococcus, 333 -, ulcers Aurococcus, 250 Sleeping sickness Borrelia, 1062 Smallpox pustules Bacterium, 674 Staphylococcus, 282 Streptococcus, 345 Soduku Streptothrix, 924 Soft chancre Hemophilus, 587 South African tick bite fever Rickettsia, 1089 South American relapsing fever Borrelia, 1064 Spanish relapsing fever Spirochaeta, 1067 Splenie anemia Streptomyces, 964 Splenomegalia Bacteroides, 581 Nocardia, 922 Sporotrichosis Actinomyces, 916 Nocardia, 911 Spotted fever, Minas Geraes Rickettsia, 1088 Spotted sickness Treponema, 1073 Stomach cancer Sarcina, 286, 290, 291 Stomatitia Micrococcus, 696 -, creamy Oospora, 922 Streptotrichosis Streptomyces, 967 Strumitis Bacillus, 855, 669, 671 Suppuration, wound Micrococcus, 242 Swamp fever, Europe Leptospira, 1078 Sycosis, bacillogenic Bacterium, 687 Syphilis

Bacterium, 687

Borrelia, 1003

Human Diseases (continued)
Syphilis (continued)
Treponema, 1971
Tabardillo
Rickettsia, 1985
Taches noires
Rickettsia, 1989
Tetanus
Bacillus, 818
Clottridum, 799
pus
Bacallus, 649
Tuk hite fever. South African

Rickettina, 1089
Tick bite, primary sores
Rickettina, 1089
Tobia fever, Colombia
Rickettsia, 1088

Mckettsia, 1055
Tonsillar abscesses
Oospore, 922
Tonsillar nocardiomycosia
Nocardia, 921

Tonsillitis
Diplococcus, 310
Streptococcus, 337
Zuberella, 578
Tonsils, infected

Tonsits, infected Micrococcus, 218, 248 Neisseria, 300 Trachoma Bacillus, 589

> Chlamydozoon, 114 Micrococcus, 260, 269 Nesseria, 301 Noguchia, 503

Treuch fever Rickettina, 1094, 1095, 1008 Spirochaeta, 1067

Trichomycosis axillaris
Microcceus, 208
Trichomycosis axillaris, red variety

Trichomy cosis axillaris, red variet Micrococcus, 266 Trichomy cosis flava

Nocardia, 922 Trichorrhexis nodosa Bacterium, 760 Tropical frambesia

Treponema, 1072
Teutsugumushi discase
Rickettria, 1089, 1091

Tuberculosis

Bacterium, 676

Gaffkya, 283 Mycobacterium, 877, 879

Proactinomyces, 923 Streptothrix, 924

Streptococcus, 343
—, bovine

---, bovine
Mycobacterium, 879, 896
Tuberculosis, pulmonary
Actinomyces, 917
Mycobacterium, 878, 897

Actinomyces, 917
Mycobacterum, 878, 88
Oospora, 923
Spirillum, 217
Streptococcus, 343
Tuberculous cavity

Bacillus, 580
Tuberculous lessons
Mycobacterium, 879

Tularemia
Pasteurella, 549
Typhoid fever

Bacillus, 380, 668, 817, 827 Eberthella, 533

Pseudomonas, 148 Salmonella, 516, 519, 527, 530 Typhus fevor

Bacterum, 686 Corynebacterium, 406 Micrococcus, 200 Richtlina, 1085, 1008 Spirochaela, 1070 Typhus, European Rackellsia, 1085

Typhus exauthematicus Richettsia, 1985 Typhus, Kenya Richettsia, 1985

Ulcers, abdominal wall Streptomyces, 966 —, genital region

Spirochaeta, 1067

—, gingival

Nocardia, 921

-, granulating skin
Aurococcus, 250
- oriental skin

-, oriental skin Micrococcus, 251 -, plarynx

Necardia, 920 ---, rectal Eubosterium, 267

Leptospira, 1077

Pseudomonas, 90

Human Diseases (continued) Western relapsing fever Ulcers, skin Borrelia, 1061 Corynebacterium, 406 Whooping cough Micrococcus, 695 Bacterium, 589, 590 Spirochaeta, 1068 Hemophilus, 587 -, thoracic Wolhynian fever Actinomyces, 915 Rickettsia, 1095 -, upper lip Wounds, gangrenous Nocardia, 920 Bacillus, 738 Ulcus vulvae acutum Wounds, infected Bacillus, 400 Bacillus, 663, 826 Undulant fever Clostridium, 773, 776, 783, 792, 794, Brucella, 561, 562 798, 799, 801, 811, 812, 825 Urethritis Diplococcus, 310 Streptobacillus, 590 Inflabilis, 823 Urinogenital suppurations Micrococcus, 696 Nesseria, 300 Plectridium, 826 Vaccinia -, superficial Spirochaeta, 1074 Corynebacterium, 385 Vaginitis -, surgical Bacillus, 826 Bacleroides, 574 Mimege, 595 Yaws, ulcerated lesions Neisseria, 301 Spirochaeta, 1063, 1068 Spirochaeta, 1074 Treponema, 1072 Veld sores, Africa Yellow fever Bacillus, 648, 659, 661, 662, 752, 819, Micrococcus, 280 --- Australia Bacterium, 613, 675, 678, 679, 681, Micrococcus, 280 Venereal discharges Clostridium, 813 Micrococcus, 279 Corunebacterium, 404 Neisseria, 296 Micrococcus, 261, 280, 281 Verruga peruana Streptococcus, 318 Bartonella, 1101 Yellow fever von it Vincent's angina Streptococcus, 340 Borrelia, 1063 Viral pneumonia Human Sources Miyagawanella, 1118 Alimentary canal Micrococcus, 251 Vitiligo Amniotic fluid Nocardia, 975 Streptococcus, 329, 330 War wounds Veillanella, 303 Corunebacterium, 402 Aorta - - gangrene Bactersum, 677 Streptococcus, 329, 330 Appendix. - - septic Bifidobacterium, 369 Sphaerophorus, 579 Catenabacterium, 368 Warts Bactersum, 684 Martellillus, 323 Weil's disease

Plectridium, 826

Registlus, 323

| Iuman Sources (continued)  | Cadaver   |
|--|---|
| Ascitic fluid  | Bacellus, 752, 819, 826                             |
| Corynebacterium, 402, 403  | Bacterium, 687                                      |
| Bartholin's gland  | Clostridium, 813, 826                               |
| Streptococcus, 329   | Streptococcus, 327                                  |
| Bladder  | Cadaver, yellow fever                               |
| Sarcina, 204   | Bacellus, 612, 659, 662, 819, 826                   |
| Blood  | Boctersum, 675, 676, 679, 687                       |
| Actinomyces, 927, 973  | Clostridsum, 813                                    |
| Alcaligenes, 413, 416  | Salmonella, 531                                     |
| Bacillus, 580, 650, 659, 668, 669, 827                               | Streptococcus, 338                                  |
| Bacterium, 553, 674, 686   | Caecum  |
| Bartonella, 1102   | Alcaligenes, 415                                    |
| Brucella, 561, 562   | Carriers  |
| Clostridium, 821   | Salmonella; 512, 514, 615, 519, 520, "              |
| Corynebaclerium, 386, 400, 403, 405,                                 |   |
| 406  | 521, 524, 525, 526, 528, 529<br>Cerebrospinal fluid |
|  |   |
| Diplococcus, 307, 311<br>Eberthella, 534                             | Corynebacterium, 404                                |
| Escherichia, 417   | Diplococcus, 307                                    |
|  | Hemophilus, 585, 589                                |
| Heliconema, 1064   | Neisseria, 296, 297, 301                            |
| Hemophilus, 585, 589   | Streptothriz, 366                                   |
| Leptospira, 1078, 1079   | Cervix  |
| Mallcomyces, 556   | Streplococcue, 341                                  |
| Micrococcus, 255, 260, 264, 272, 277                                 | Cervix evudate                                      |
| Mayagawanella, 1116  | Chlamydozoon, 1115                                  |
| Nejsseria, 296, 297<br>Nocardia, 97,5                                | Vibrio, 198   |
|  | Chyluria  |
| Pasteurella, 549, 551  | Bacillus, 651                                       |
| Proleut, 400, 401  | Conjunctiva   |
| Ricketheia, 1085, 1002, 1008   | Bacellus, 500, 666                                  |
| Salmonella, 512, 514, 518, 528, 531                                  | Bactersum, 677, 684, 689                            |
| Sphacrophorus, 579, 580  | Chlamydocoon, 1115                                  |
| Specilium, 217   | Corynebacler, um, 385, 386                          |
| Spirochaeta, 1067, 1069, 1070  | Diplococcus, 311                                    |
| Streptococcus, 316, 321, 326, 327, 329, 330, 336, 310, 311, 343, 314 | Hemophilus, 585                                     |
| Streptomyces, 960, 965   | Мистосотема, 248, 257, 261                          |
| Vibria, 201  | Mimeae, 503   |
| Blood culture, past mortem   | Morarella, 531, 532                                 |
| Clostridium, 798   | Netwerta, 296, 297                                  |
| Blood, putrefying  | Parinia, 691  |
| Spirillum, 217   | Sarcina, 201  |
| Blood vessels  | Conjunctival exudste                                |
| Ricketlara, 1086   | Chlamydo:con, 1115                                  |
| lindy secretions   | Cornea  |
| Microcoreus, 210, 261  | Actinomyces, 969, 073                               |
| Brain  | Chlamydozoon, 1115                                  |
| Streptococcus, 310   | Digestive tract                                     |
| Breast   | Diplococcus, 309, 310                               |
| Actinomyces, 927   | Merococcus, 217, 251                                |

Streptococcus, 320, 332

Actinomyces, 927 Buccal cavity, see Mouth cavity

Human Sources (continued) Genital tract Digestive tract (continued) Staphylococcus, 281, 282 Veillonella, 303 Genitalia Duodenum Bacteroides, 574 Bacterium, 688 Borrelia, 1063 Staphylococcus, 701 Genitourinary tract Streptococcus, 702 Chlamydozoon, 1115 Ear Klebsiella, 458 Corynebacterium, 403 Gums Endothelial cells Streptococcus, 310 Bartonella, 1102 Hair Richettsia, 1086 Micrococcus, 253 Epithelial cells, intestinal mucosa - beard Rickettsia, 1085 Bacterium, 687 Eve -, follicles Bacillus, 655 Bacterium, 686 Micrococcobacillus, 690 Corynebacterium, 387 Staphylococcus, 282 Micrococcus, 259 Eyelid -, showing trichorrhexia Actinomyces, 972 Bacterium, 688 Female genital canal Healthy persons Coccus, 250 Vibrio, 204 Micrococcus, 210, 252 Heart Female genital tract Bacterium, 677 Coccus, 250 Intestine Gaffkya, 284 Aerobacter, 455 Vibrio, 205 Alcaligenes, 413, 415 Bacillus, 659, 671, 739, 741, 745, 746, Female genitalia 747, 757, 758, 813, 814, 815, 817, Bacteroides, 567 825, 826, 918 Food handlers Bacterium, 580, 672, 677, 678, 686 Salmonella, 512, 519, 521, 524, 526, Bacteroides, 567, 568, 569, 570, 571, 527, 530, 531 572, 573, 674 Foot Bifidobacterium, 369 Bacellus, 658, 661, 662, 670, 671 Butyribacterium, 369 -, skin of Catenabacterium, 368 Sarcina, 290 Clostridium, 781, 794, 799, 800, 809, Gall bladder 820, 821 Bacillus, 612 Corynebacterium, 402, 404 General Eberthella, 533, 531 Streptococcus, 338, 343 Escherichia, 447, 449, 450 Genital canal Eubacterrum, 367, 368 Bacillus, 361, 362, 580 Klebsiella, 458 Corynebacterium, 402 Lactobacillus, 353, 354, 361 Streptococcus, 336 Microbacterium, 370 Streptostaphylococcus, 345 Micrococcus, 248, 251, 272, 274 Genital mucous membranes Microspira, 202, 203 Borrelia, 1063 Neisseria, 301 Genital secretions Paracolobactrum, 460 Miyagawanella, 1116 Proteus, 489 Treponema, 1071, 1072

Human Sources (continued) Maxilla Intestine (continued) Robertsontlius, 823 Pseudomonas, 97, 145, 146, 147, 148, Mouth eavity Actinomyces, 926, 927, 971 Risiella, 577 Ascococcus, 250, 693 Salmonella, 462, 516, 523 Barrillus, 365, 380, 650, 656, 657, Sarcina, 292 667, 743, 744 Shigella, 539, 542, 543 Bactersum, 676, 678, 679, 687, 761 Sphaerocillus, 580 Bacteroides, 574 Spirillum, 217 Bifidobacterium, 369 Spirochaeta, 1067, 1074 Borrelia, 1062 Streptococcus, 326, 327, 328, 330, 331 Catenabactersum, 368 Veillonella, 304 Coccus, 694 Vibrio, 194, 198, 204, 205 Corynebactersum, 386, 402, 401, 405 Zuberella, 577, 578 Diplococcus, 310 Jaints Fusebacterium, 582, 583 Commedacterium, 386 Helicobacterium, 600 Neisseria, 206, 297 Jodococcus, 695 Kidney Lactobacillus, 361 Bacterium, 677 Leptospera, 1079 Corunebacterium, 400 Leptothriz, 365, 366 Spirochaeta, 1067 Leptotrichia, 364, 365 Large intestine Micrococcus, 248, 251, 257, 260, 262, Micrococcus, 247 263, 264, 269, 273, 277, 696 Laryax Neisseria, 300 Corynebactersum, 385 Proactinomuces, 923 Sareina, 204 Bacillus, 658, 659, 660, 662, 667 Spirillum, 215 Bacterium, 613, 676, 679, 683, 685 Spirochaeta, 1065, 1066, 1070, 1074. Bartonella, 1102 1079 Clostridium, 821 Staphylococcus, 703 Pasteurella, 510, 551 Streptococcus, 316, 320, 321, 323, 329, Streptococcus, 338 Streptomyces, 967 330, 331, 333, 336, 338, 339, 341, 312, 313, 314 Actinomyces, 927, 968 Trepomema, 1072, 1075 Bacellus, 667 Verlionella, 302, 303, 301 Corunebacterium, 386 Pibria, 203, 201, 205, 206, 207, 703 Hemophilus, 589 Mouth cavity, putrid tissue Meyagawanella, 1118, 1119 Clostridium, 820 Gospora, 922 Granulobacter, 822 Spirillum, 217 Mucous membrane Spirochaela, 1065 Bacteroides, 571 Streptococcus, 329, 330, 331, 332, 243 Pasteurella, 552 l'eillonella, 302 Streptororcus, 312, 314 Lamph glands - - mouth cavity Bacellus, 868

Bacterium, 689

Diplococcus, 310

Bartonella, 1101, 1102

Corynebacterium, 402, 407, 401 Lymphoid tissues Caryophanon, 1001

Mecrococcus, 274, 276

----, nasal

Sarcina, 292

Zuberella, 578

Human Sources (continued) Diplococcus, 310, 311 Mucous membrane, nose and throat Streptococcus, 320, 321 Neisseria, 301 Pia mater -- respiratory tract Nocardia, 975 Borrelia, 1062, 1063 Pleural fluid Dialister, 595 Pasteurella, 549 Gaffkya, 283 Preputial secretions Neisseria, 298, 299, 301 Bacillus, 612 Mucus Rectum Bacillus, 737 Alcaligenes, 415, 416 Mucus, intestinal Bacillus, 650 Bacillus, 648, 649, 664, 679 Red perspiration -, nasal Micrococcus, 263 Bacillus, 658, 659, 667, 669 Red ous Corynebacterium, 406, 407 Bacterium, 685 Micrococcus, 257, 278 Respiratory mucous membrane, see Neisseria, 301 Mucous membrane, respiratory tract Pseudomonas, 95 Respiratory system Streptococcus, 342, 341 Cillobacterium, 369 Vibrio, 203 Diplococcus, 307 Nasal washings Eubacterium, 368 Veillonella, 303 Respiratory tract Nasopharyngeal secretions Hemophilus, 585, 586, 587, 589 Dialister, 595 Klebsiella, 458 Neisseria, 301 Neiszeria, 298, 299, 300 Streptococcus, 316, 319, 321, 331, 332, Nasopharyny Hemophilus, 585 333, 334 Neisseria, 297, 298, 299, 301 Saliva Pasteurella, 581 Bacillus, 647, 671 Staphylococcus, 282 Diplococcus, 307 Zuberella, 577 Flavobacterium, 410 Leptothrix, 366 Natural cavities Micrococcus, 258, 275 Gaffkya, 284 Neisseria, 298 Veillonella, 303 Staphylococcus, 282 Nerves, peripheral Streptococcus, 320 321, 337, 344 Mycobacterium, 882 Verllonella, 301 Nose Scalp Corynebacterium, 385, 403 Micrococcus, 265 Diplococcus, 311 Sebaccous glands Micrococcus, 260, 262 Corynebactersum, 387 Sarcina, 292 Sinuses Streptococcus, 318, 321 Hemophilus, 585 -, mucous membrane, see Murous Streptococcus, 321, 333 membrane, nasal Oral cavity, see Mouth cavity Bacillus, 647, 650, 651, 655, 656, 658, Organs, internal 660, 661, 662, 663, 668, 670, 671, Leptospira, 1078 742, 743 Peritoneum Bacterium, 674, 683, 686 Bacillus, 666 Corynebaclerium, 386, 403, 406 Pharvnx Eubacterium, 368 Corynebacterium, 385, 403

referring to the type of lesion caused on the blades of oats.

Rods: 0 66 by 1.76 microns. Motile with one to several flagella. Capsules Gram-negative.

Green fluorescent pigment produced

Gelatin, Liquefied. Becf-peptone agar colonies White,

raised, margins entire or slightly undulating

Broth: Clouding in layers Ring and slight pellicle

Milk: Alkaline, sometimes a soft eurd which digests or clears

Slight production of nitrites from nitrates

Indole not produced

Acid but not gas from glucose, fructose and sucrose. No acid from lactose, mal-

tose, glycerol and mannitol Starch : Hydrolysis slight.

Optimum temperature 22°C Optimum pH 6.5 to 7.0

Acrobic

Distinctive characters Differs from Pseudomonas coronafaciens in that the cells are somewhat smaller and the pathogen produces a streak on oat blades instead of a halo spot

Source · Forty cultures isolated from oats gathered in various parts of America

Habitat: Pathogenic on cultivated oats, and to a slight degree, on barley.

67. Pseudomonas tomato (Okabe) comb nov. (Bactersum tomato Okabe, Jour Soc Trop Agr Formosa, 5, 1933, 32, Phylomonas tomalo Magrou, in Hauduroy et al , Dict. d Bact. Path , Paris, 1937,

422 ) Named for the host plant, tomato Probable synonym · Bacterium punc-

tulans Bryan, Phytopath., 23, 1933, 897 Rods: 0 60 to 0 97 by 1 8 to 6 8 microns Motile with 1 to 3 polar flagella

negative. Green fluorescent pigment produced in culture. ,

Gelatin: Slow liquefaction.

Beef-extract agar colonies White, circular, flat and glistening.

Broth: Turbid in 21 hours Pellicle

Milk: Becomes alkaline and clears Natrites are usually produced from nitrates

Indole not produced

No H.S produced.

Acid but not gas from glucose, sucrose and lactose No acid from maltose and glycerol.

Starch hydrolysis feeble. Slight growth in 3 per cent salt

Optimum temperature 20° to 25°C. Maximum 33°C.

Aerobic

Source. Isolated from diseased tomato leaves

Habitat Pathogenic on tomato, Lucopersicon esculentum

68 Pseudomonas aceris (Ark) Burkholder (Phytomonas aceris Ark, Phytopath , 29, 1939, 969, Burkholder, Phytopath , \$2, 1942, 601 ) From Latin acer. maple, M L Acer, generic name.

Rods 0.3 to 0 8 by 0.8 to 2 5 microns. Motile with 1 to 2 polar flagella. Gram-

negative

Green fluorescent pigment produced

Gelatin: Liquified Beef-extract-peptone agar. Colonies are

gravish-white Appearing in 24 hours. Broth Turbid.

Milk Clearing with no coagulation Nitrates not produced from nitrates

Indole not produced Hydrogen sulfide not produced.

Acid from glucose, fructose, galactose, arabinose, aylose, sucrose, maltose, lactose, raffinose, mannitol, glycerol and didectol

Slight growth in broth plus 6 per cent salt (Burkholder)

Temperature . 13° to 31°C.

Source From diseased leaves of the large leaf maple, Acer macrophillum

Habitat: Causes a disease of Acer spp

69 Pseudomonas angulata (Fromme and Murray | Holland | Bacterium angulatum Fromme and Murray, Jour Agr. Res , 16, 1919, 219; Holland, Jour. Bact . 5, 1920, 221; Phytomonas angulata Bergey

| Human Sources (continued)               | Spirochada, 1067, 1074                  |
|---|---|
| Tongue, epithelium                      | Streptococcus, 323, 331, 332            |
| Micrococcus, 267                        | Vaccine pustules                        |
| Tonsillar crypts                        | Corynobacterium, 401                    |
| Actinomyces, 927                        | Vagina                                  |
| Vibriothrix, 833                        | Bacillus, 580, 612, 652, 667            |
| Tonsillar granules                      | Lactobacillus, 362                      |
| Spirillum, 218                          | Leptothrix, 356                         |
| Tonsils                                 | Mimeac, 595                             |
| Alcaligenes, 416                        | Neisseria, 301                          |
| Bacıllus, 583                           | Streptococcus, 318, 319, 327, 329, 330, |
| Corynebacterium, 405                    | 332, 333, 334, 337, 338                 |
| Diplococcus, 310                        | Vaginal secretions                      |
| Sphaerophorus, 579                      | Micrococcus, 261, 278                   |
| Streptococcus, 338                      | Vulva                                   |
| Veillonella, 301                        | Streptococcus, 338                      |
| Trachea                                 | Ice                                     |
| Corynebacterium, 385                    |   |
| Urethra                                 | Micrococcus, 272                        |
| Corynebacterium, 404                    | Ice Cream, see Dairy Products           |
| Leptothrix, 366                         | Infusions                               |
| Micrococcus, 248                        | Asparagus                               |
| Streptobacillus, 590                    | Bacillus, 650                           |
| Streptococcus, 310                      | Bacterium, 679                          |
| Urethral exudate                        | Micrococcus, 262                        |
| Chlamydozoon, 1115                      | Bean                                    |
| Urinary tract                           | Bacillus, 657, 664, 669, 750            |
| Micrococcus, 248                        | Bactereum, 679, 685                     |
| Neisseria, 300                          | Micrococcus, 262, 264, 268, 271, 273,   |
| Staphylococcus, 282                     | 279                                     |
| Urine                                   | Spirillum, 218                          |
| Bacillus, 617, 652, 653, 655, 660, 661, | Beci                                    |
| 663, 664, 668, 669, 671, 741, 757, 758  | Clostridium, 811, 821                   |
| Bacterium, 678, 688, 760                | Brewer's grain                          |
| Bacteroides, 574                        | Bacillus, 656                           |
| Leptospira, 1077, 1073                  | Carrot                                  |
| Micrococcus, 238, 217, 260, 266, 267,   | Micrococcus, 261, 264                   |
| 269, 279, 280                           | Streptococcus, 341                      |
| Mycobacterium, 890                      | Cheese and white beets                  |
| Proteus, 490, 491                       | Bacillus, 711                           |
| Salmonella, 518, 531                    | Corn                                    |
| Sarcina, 289, 293                       | Bacillus, 650, 748                      |
| Spirochaeta, 1067, 1070                 | Bacterium, 681                          |
|   | Digitalis                               |
| Spiroschaudinnia, 1071                  | Bacillus, 745                           |
| Staphylococcus, 282                     | Micrococcus, 262, 263                   |
| Streptococcus, 323, 338, 340, 341       | Egg white, cooked                       |
| Jterus                                  | Bacillus, 757                           |
| Actinomyces, 580                        | Fermenting                              |
| Bacillus, 668                           | Bacillus, 672                           |
| Proteus, 490                            | ·                                       |

| Human Sources (continued)               | Proactinomyces, 923                     |
|---|---|
| Skin (continued)                        | Pseudomonas, 698                        |
| Gaffkya, 283                            | Sarcina, 293, 291                       |
| Micrococcus, 239, 242, 243, 244, 251,   | Serratia, 484                           |
| 252, 254, 255, 256, 257, 258, 259,      | Smrillum, 701                           |
| 262, 274, 695                           | Streptococcus, 320, 321, 340, 341,      |
| Mycobacterium, 882                      | 343, 344                                |
| Nocardia, 919, 921                      | Streptothrix, 921                       |
| Plocamobacterium, 691                   | Vibrio, 198                             |
| Pseudomonas, 148                        | -, green                                |
| Rickettsta, 1086                        | Pseudomonas, 149                        |
| Sareina, 288, 290                       | Stornach                                |
| Streptococcus, 318, 333, 343            | Actinomyces, 969                        |
| Skin, dry scalp lesions                 | Alcaligenes, 416                        |
| Discomyces, 975                         | Bacillus, 647, 650, 866                 |
| Skin of foot                            | Eubaclerium, 367                        |
| Micrococcus, 251, 252, 256, 262         | Helicobacterium, 690                    |
| Smegma                                  | Sareina, 286, 290, 291, 294             |
| Mycobactersum, 890                      | Stomach contents                        |
| Sarcina, 291                            | Bacillus, 814                           |
| Treponema, 1072                         | Gaffkya, 281                            |
| Spinal fluid                            | Submavillary lymphatic gland (child)    |
| Bacillus, 667                           | Micrococcus, 280                        |
| Miyagawanella, 1176                     | Sneat                                   |
| Salmonella, 522                         | Bacillus, 666, 673                      |
| Spicen                                  | Tear duct                               |
| Baerllus, 613                           | Actinomyces, 970                        |
| Bacterium, 677                          | Tecth                                   |
| Brucella, 561                           | Acidobacterium, 361                     |
| Pasteurella, 549, 551                   | Aerobacter, 456                         |
| Salmonella, 522                         | Fusobacterium, 582, 583                 |
| Streptococcus, 311, 314                 | Granulobacter, 823                      |
| Streptomyces, 958, 962, 963, 964        | Streptococcus, 320, 339, 340, 341, 342  |
| Sputum                                  | , carrous                               |
| Actinomyces, 916, 917, 970, 972         | Baerllus, 653                           |
| Bacellus, 617, 653, 661, 665, 667, 668, | Micrococcus, 262                        |
| 669, 672, 703, 738, 740, 741, 752,      | -, decayed                              |
| 751, 018                                | Cladothrax, 918, 974                    |
| Bactersum, 761                          | Throat                                  |
| Hrucella, 693                           | Corynebactersum, 356, 387, 401, 406     |
| Cladothrix, 974                         | Diplocaceus, 311                        |
| Diplococcus, 307                        | Micrococcus, 280                        |
| Goffkya, 283                            | Spirochaeta, 1065                       |
| Hemophilus, 585                         | Streptococcur, 316, 318, 320, 321, 333, |
| Klebnella, 458, 459                     | 331, 335, 337, 339, 341, 342, 343       |
| Micrococcus, 257, 267, 277              | Veillonella, 303                        |
| Mayagawanella, 1119                     | Tongue                                  |
| Moraxella, 572                          | Acidobacterium, 361                     |
| Nemeria, 208                            | , deposit on                            |
| Nacardia, 920, 921, 976                 | Nocardia, 920                           |

Streptococcus, 310 Vibrio, 205

Oospora, 922, 923, 976 Pasteurella, 519

661

Potosia cuprea, 808

Prodenia litura, 684

Protoparce sp., 491

Procryptotermes sp , 1121

Pyrameis (Vanessa) cardui, 667

Insecta (continued) Leptinotarsa decemlineata, 419, 440, 660 Leucotermes lucifugus, 1067 Linognathus stenopsis, 1097 Locusta migratoria, 666 Lucilia caesar, 780 Lucilia sericata, 274, 301, 748 Lygus pratensis, 603 Lymantria dispar, 739 Lymantria monacha, 267, 618, 651, 652, 659, 660, 663, 682, 749, 753, 755 Malacosoma americana, 416 Malacosoma castrensis, 690 Melanoplus femurrubrum, 665 Melolontha melolontha, 336, 662, 681, 690, 753, 757 Musca domestica, 282, 528, 677 Neotermes howa, 1121 Neurotoma nemoralis, 268, 663 Neurotoma nemoralis, larvae of, 268 Naciusdae, 491 Oncopellus fasciatus, 490 Orayia pudibunda, 670 Pectinophora gossypiella, 664 Pedicinus longiceps, 1085 Pedieulus humanus, 664, 1060, 1097 Pediculus humanus var. capitis, 1085, Pediculus humanus var. corporis, 1085, 1005 Pediculus vestimenti, 1061, 1062 Periplanela americana, 217, 405, 425 Periplaneta orientalis, 652, 1069 Phlebotomus noguchii, 1102 Phlebotomus perniciosus, 1074 Phlebotomus verrucarum, 1102 Photuris pennsylvanicus, 491 Pieris brassicae, 336, 665, 666, 690 Pieris rapae, 271, 440, 737 Polyplax serrata, 1112 Polyplax spinulosus, 1086, 1101 Popillia japonica, 727 Porthetria dispar, 250 Porthetria (Lymantria) dispar, 336,660,

Pyrausta nubilalis, 200, 259, 452, 685, 690, 750, 759, 760, 761 Reticulitermes flavipes, 1003 Reticulitermes lucifugus, 1069 Rhagoletis pomonella, 141 Rhodnius prolizus, 914 Sceliphron cementarium, 605 Scoliopleryx libatrix, 659 Simulium noelleri, 1068 Stomozys calcitrans, 677 Stylopyga orientalis, 1076 Stylopyga (Blatta) (Periplaneta) orientalis, 1075 Temmorhinus (Cleonus) mendicus, 652 Tenebrio molitor, 634, 680 \*Termes lucifugus, 1070 Thyridopteryx ephemeraeformis, 392, 604 Tibicen linner, 269, 608 Triatoma rubrofasciata, 1008 Trichodectas pilosus, 1097 Urographus fasciata, 420 Vanessa polychlorus, 655 Vanessa utricae, 653, 656 Xenopsylla astra, 1986 Xenopsylla cheopis, 1086, 1104 Insect Diseases, see Insects Insects, see Insecta for Scientific Names Apple magget Pseudomonas, 141 Bagworm Bacterium, 601 Corynebacterium, 392 Bedbug Bacterium, 605 Borrelia, 1060 Corynebacterium, 392 Haemobarionella, 1104 Bec moth Bacterium, 759, 762 Escherichia, 452 Microececus, 259 Streptococcus, 340 Vibrio, 200 Bees Bacillus, 693 Bacterium, 673, 676 Bifidobacterium, 369 Proteus, 490 Salmonella, 532

| infusions (continued)                      | Blotta (Periplaneta) orientalis, 740     |
|--|--|
| General                                    | Blisaus leucopterus, 264                 |
| Bacillus, 755                              | Bombyz mori, 254, 265, 282, 336, 337,    |
| Proteus, 488                               | 342, 481, 490, 650, 652, 739, 751        |
| Hay  | Calotermes (Glyptotermes) iridipennis,   |
| Aerobacter, 456                            | 583, 742                                 |
| Bacillus, 711, 743, 815, 824               | Calotermes spp., 1070                    |
| Herbs                                      | Ceratomia catalpae, 746                  |
| Spirochaela, 1053                          | Chironomus plumosus, 173                 |
| Jequirity seed                             | Chironomus sp , 635                      |
| Bacillus, 672                              | Cimez hirundinis, 1096                   |
| Koblrabs                                   | Cimex lectularius, 392, 605, 1060, 1096  |
| Vibria, 206                                | 1101                                     |
| Leaves, indigo plant                       | Cunex rotundatus, 1062                   |
| Bacillus, 659                              | Cliesocampa fragilis, 660                |
| Lentals                                    | Cnethocampa pityocampa, 342, 684         |
| Baerllus, 711                              | Coccinella novemnotata, 431, 440         |
| Malt                                       | Coenagrionidae, 269                      |
| Micrococcus, 263                           | Conocephalus fasciatus, 440              |
| Meat                                       | Clenocophalides felis, 1006              |
| Bacellus, 654                              |  |
| Pseudomonas, 117                           | Ctenocephalus felis, 1066                |
| -, extract                                 | Ctenocephalus sp., 1104                  |
| Micrococcus, 255, 207                      | Culex fairgans, 1006                     |
| -, putrefying                              | Culex piptens, 1098                      |
| Micrococcus, 231, 236                      | Culez sp , 1068                          |
|  | Danais archipus, 260                     |
| Potato                                     | Diabrotica sp., 124                      |
| Bacellus, 650                              | Diapheroinera femorata, 433, 679         |
| Putrefying                                 | Diprion sertifer, 668                    |
| Bacterium, 682<br>Snakeroot                | Drosophila confusa, 1075                 |
| Mierococcus, 263                           | Eacles imperiality, 603                  |
|  | Echidnophaga gallinacea, 1986            |
| Vegetable Bactillus, 654, 656, 671         | Encaptolopus sordidus, 665               |
|  | Ephestia Luchniella, 259, 260, 617, 759  |
| Bacterium, 675, 679, 691, 687, 688,<br>689 | Euxon regelum, 336, 425, 460, 689        |
| Micrococcus, 277, 278, 280                 | Euxon (Agrotis) segetum, 737             |
|  | Galleria mellonella, 200, 259, 310, 452, |
| Pseudomonas, 147, 148 Wheat                | 759, 762                                 |
| Bacellue, 630                              | Gelechta goreypiella, 678, 686           |
| · ·  | Glessina palpalis, 1062                  |
| Insecta, Scientific Names                  | Glyptolermen pridipennis, 1075, 1076.    |
| Adoretus compressus, 657                   | 1121                                     |
| Ametermes minimus, 980                     | Gortyna ochracea, 657                    |
| Anasa trishs, 651                          |  |
| 1 pre mellifera, 490, 618, 657, 660, 667,  | Grylletalpa gryllotalpa, 745             |
| 669, 679, 673, 676, 693, 721, 726, 737,    | Hyponomeula econymella, 750, 751         |
| 738, 740, 741, 749, 757                    | Hyponomeula sp 267                       |
| t pis mellifica, 206, 326, 327, 337, 422   | Izophya (Barbstrales) amplipennis, 739   |
| ircha caja, 600                            | Kalotermes sp , 1003, 1121               |
| Blatta germanica, 402                      | Lachnosterna op , 269                    |
| Blatta orientalis, 1993                    | Lathrideux rugicollis, 971               |

Larvac Bacillus, 649

| Insects (continued)                   | Leaf beetle   |
|---------------------------------------|---|
| Fleas, rat (continued)                | Bacterium, 679  |
| Pasteurella, 549                      | Lice  |
| Rickettsia, 1086, 1087                | Bacillus, 664   |
| Flies                                 | Borrelia, 1060, 1061  |
| Salmonella, 528                       | Richettsia, 1085, 1095, 1097, 1099                                      |
| Staphylococcus, 282                   | - biting  |
| -, black                              | Ricketisia, 1007  |
| Spirochaeta, 1068                     | - body  |
| -, blue bottle                        | Rickettsia, 1085  |
| Micrococcus, 274                      | -, goat   |
| Neisseria, 301                        | Rickettsia, 1007  |
| -, fruit                              | - head  |
| Treponema, 1075                       | Rickettsia, 1085  |
| -, green blow                         | -, mouse  |
| Bacillus, 748                         | Eperythrozoon, 1112   |
| -, tsctso                             | -, rat  |
| Borrelia, 1062                        | Rickettsia, 1086, 1104  |
| Fly larvac                            | Locusts   |
| Bacterium, 677                        | Bacellus, 666   |
| , blue bottle                         | - diseased  |
| Clostridium, 780                      | Micrococcus, 251  |
| General                               | May fly nymph shells  |
| Leptothrex, 368                       | Chitin-digesting bacteris, 632  |
| Micrococcus, 281                      | Meal worm   |
| Rickettsia-like organisms, 1098, 1099 | Bacterium, 634, 680   |
| Grasshoppers                          | Mediterranean flour moth  |
| Eberthella, 534                       | Bacillus, 647   |
| Flavobacterium, 440                   | , larvae  |
| Gypsy moth                            | Micrococcus, 259, 260   |
| Bacillus, 660, 661, 739               | Midge   |
| Gyrococcus, 250                       | Bacterium, 635  |
| Streptococcus, 336                    | -, larvae   |
| Hornworm septicenus                   | Pseudomonas, 173  |
| Proteus, 491                          | Milkweed bugs   |
| Imperial moth                         | Eberthella, 534   |
| Baclerium, 608                        | Proteus, 490  |
| Japanese beetle, Milky disease        | Monarch butterfly larvae, wilt disease                                  |
| Bacillus, 727                         | Micrococcus, 261  |
| , milky disease, Type B               | Mosquito  |
| Bacillus, 727                         | Rickettsia, 1096, 1098  |
|                                       | , feces   |
| June bug or beetle                    | Micrococcus, 280  |
| Bacillus, 746                         | -, larvae   |
| Micrococcus, 269                      | Spirochaeta, 1068   |
| Lady beetle larvae                    | Moth 27 050 000 737 750 754   |
| Flavobacterium, 440                   | Bacillus, 659, 660, 737, 750, 754<br>Bacterium, 678, 682, 684, 686, 689 |
| Lady beetle, nine-spotted             | Coccobacillus, 690  |
| Flavobacterium, 431, 440              | Paracolobactrum, 460  |
| Larvac                                | Streptococcus, 336  |
| 77 7724 (4 6.10)                      | Dischington 1   |

| Insects (continued)               | Bacterium, 608                    |
|-----------------------------------|-----------------------------------|
| Bees and larvae                   | Micrococcus, 269                  |
| Bacillus, 648 667, 669, 670       | Cockehafer                        |
| -, diseased                       | Bacillus, 662, 753, 757           |
| Bacillus, 657, 738, 740, 749, 757 | Baclersum, 681                    |
| -, foulbrood                      | Diptobacillus, 690                |
| Bacillus, 737, 744                | Streptococcus, 336                |
| Micrococcus, 266                  | Cockmach                          |
| Streptococcus, 326, 327, 337      | Bacillus, 740                     |
| -, foul broad, American           | Fusiformis, 694                   |
| Bacillus, 726                     | Sarcina, 291                      |
| -, foulbrood, benign              | Spirochaeta, 1069                 |
| Bacillus, 660                     | Treponema, 1075                   |
| -, foul brood, European           | -, fat body                       |
| Achromobacter, 422                | Bacillus, 652                     |
| Bacillus, 721                     | Corynebactersum, 402, 405         |
|                                   |                                   |
| -, infectious disrrhoes           | -, feces                          |
| Proteus, 490                      | Achromobacter, 425                |
| Beetle larvae                     | -, intestine                      |
| Achromobacter, 420                | Arthromitis, 1003                 |
| Beetles                           | Spirillum, 217                    |
| Actinomyces, 971                  | Treponema, 1076                   |
| Bacillus, 657                     | Colorado potato bectle, intestine |
| Fusiformia, 601                   | Achromobacter, 419                |
| Pseudomonas, 124                  | Bacellus, 660                     |
| Blood-sucking insects             | Flacobacters um, 440              |
| Pasteurella, 551                  | Corn borer, European              |
| Blue bottle fly larvae            | Bacellus, 750                     |
| Clostridium, 780                  | Baclerium, 685, 759, 760, 761     |
| Butterfly                         | Coccobacellus, 600                |
| Bacillus, 653, 655, 656, 667      | Ercherichia, 452                  |
| Cabbage butterfly                 | Micrococcus, 259                  |
| Bacillus, 605, 666, 737           | Vibrio, 200                       |
| Diplobacillus, 600                | Cricket                           |
| Flat obacterium, 440              | Bacıllus, 745                     |
| Streptococcus, 33G                | Cutworm septicemia                |
| , larvae                          | Proteus, 491                      |
| Micrococcus, 271                  | Damsel fly                        |
| Caterpillars                      | Mierococcus, 269                  |
| Bacellus, 657                     | Firefly                           |
| Bactersum, 612                    | Proteus, 491                      |
| Coccobacillus, 600                | Fleas                             |
| Pseudomonas, 91, 148              | Haemobartonella, 1104, 1106       |
| Streptococcus, 339                | , cat                             |
| —, Ieces                          | Rickettsia, 1006                  |
| Pseudomonas, 148                  | Spirochaeta, 1066                 |
| -, wilt discuse                   | - chicken                         |
| Microeoceus, 261                  | Rickettsia, 1086                  |
| Chinch bug, carcal organs         | —, dog                            |
| Vicrococcus, 261                  | Haemolartonella, 1111             |

-, rat

Cicada, Lymman

- salıva

Streptococcus, 304

Mammais (continued) Gerbilles, erythrocytes Chimpanzee, feces Hemobartonella, 1108 Clostridium, 785 Ground hogs -, general Pasteurella, 551 Spirochaeta, 1079 Hamsters, erythrocytes Deer mause, erythrocytes Grahamella, 1110, 1111 Grahamella, 1111 Haemobartonella, 1104 Haemobartonella, 1106, 1107, 1108 Hamsters, Chinese Deer mouse, gray-backed Erythrocytes Erythrocytes Haemobartonella, 1108 Eperythrozoon, 1113 Jerboa, erythrocytes Haemobartonella, 1107 Haemobartonella, 1108 Domestic animals, general Laboratory animals Salmonella, 523 Streptococcus, 317 Streptococcus, 317, 318 Lemmings ----, lymph Pasteurella, 551 Corynebacterium, 401 Moles, erythrocytes ---, mouth cavity, mucous membrane Grahamella, 1109 Caryophanon, 1001 Monkeys --- throat Bartonella, 1108 Streptococcus, 334 Spirochaeta, 1068 Dormice, crythrocytes -, blood Haemobartonella, 1108 Rickettsia, 1088 Ferrets Spirillum, 1065 - erythrocytes Brucella, 563 Grahamella, 1111 - respiratory tract Hemophilus, 589 Haemobartonella, 1104 -, infected with yellow fever virus Flying fox, intestine Corynebacterium, 404 Acuformis, 813 -, trachoma Bacillus, 818 Chlamydozoon, 1114 Foxes Musk rats Salmonella, 517, 525 Pasteurella, 551 General Streptococcus, 338 Opossum, blood Spirochaeta, 1066 -, intestine --- ervthrocytes Bacillus, 817, 826 Haemobartonella, 1108 Racteroides, 567, 568, 569, 570, 571, Otter, blood 572, 573, 574 Snirochaeta, 1067 Butyribacterium, 380 Primates, lower Clostridium, 796, 810 Salmonella, 502 Lactobacellus, 354 Rodents Streptococcus, 331 Pasteurella, 549, 551 -, mouth Salmonella, 517, 527 Streptococcus, 331 Spirochaeta, 1068 -, mucous membrane Streptococcus, 310 Bacteroides, 574 --- blood Streptococcus, 242, 243, 244 Borrelia, 1064 ---, natural cavities of mammals Shrew mouse Gaffkya, 284 Spirochaela, 1066

Shrew, short tailed

Inserts (continued) Moth (continued) - crushed eer masses Alcaligenes, 416 Mud dauber wasp Bacterium, 605 Nun moth Bacellus, 648, 651, 652, 659, 660, 663, 749, 753 755 - - larvae Micrococcus, 267 Olive fiv Bacellus, 647 Pink bollwarm Bacellus, 664 Processionary moth Bacterium, C84 Streptococcus, 342 Reduvid bug Nocardia, 914 Rickettria, 1009 Hoseleaf beetle Clostridium, 808 Sandfly Bartonella, 1102 Spirochaeta, 1074 Sawily Baniina, 663, 668 Silkworm Bacellus, 630, 652 Proteus, 490 Serratia, 481 Staphylococcus, 282 Streptococcus, 336, 342 enegro bna boold .--Micrococcus, 254, 265 -, discased Barillus, 739 Мистососсия, 265 Streptococcus, 337 Sphing moth Bacillus, 746 Squash bug Barillus, 634 Sunk bugs Eberthella, 531 Tarnished plant bug Bacterium, 603 Tent caterpillar Barillus, 746

Termites

Caryococcus, 1121 Fusiformis, 583 Spirochaeta, 1067 Treponema, 1075, 1076 - intestine Arthromitis, 1003 Bacsllus, 728, 742 Colcomitus, 1003 Micromonos pora, 980 Spirochaeta, 1069, 1070 Tettigonids, diseased Bacellus, 739 Tipulid Funtormis, 694 Walking stick Bactersum, 679 Florobaetersum, 433 Wasps Salmonella, 532 Weevils Bacillus, 652 Winter wheat cut worm Achromobacter, 425 Leaven, see Yeast Mammals, also see Cats, Cattle, Dors, Goats, Guinea pigs, Hogs, Horses, Mice, Rabbits, Rats, and Sheep Ant eater, five-toed Bartonella, 1103 Ape, slimentary tract Serratia, 481 Benderont Cornella, 1093 Bat, blood Spirochaeta, 1070 Spironema, 1070 -, erythrocytes Bartonella, 1108 Grahamella, 1110, 1111 - intestine Chitin digesting bacteria, 632 Buffaloes, blood Spirochaeta, 1005 -, erythrocytes Hoemobartonella, 1106 -, leucocytes Rickettera, 10% Camel Salmonella, 513 Carnivors Salmonella, 800

Sea calf Septicemia

Mammals Diseases of, (continued) Kangaroos (continued) Septicemia Nocardia, 921 Laboratory animals Brucellosis Brucella, 561, 562 Monkeys Abortion Brucella, 562 Brucellosis Brucella, 562, 563 Conjunctival folliculosis Noguchia, 594 Conjunctivitis, granular Noguchia, 593 Conjunctivitis, inflammatory Nonuchia, 594 Fever, boutonneuse Ricketlsia, 1089 Fever, relapsing Spirochaeta, 1069 Tuberculosis, bovine Myeobacterium, 879 Tuberculosis, human Mycobacterium, 878 Moose Tick paralysis Klebsiella, 459 Mules Botulism Clostridium, 779 Gangrenous dermatitus Sphaerophorus, 579 Reindeer Hemorrhagic septicemia Pasteurella, 549 Rodents Eperythrozoonosis Eperythrozoon, 1111 Glanders-like disease Malleomyces, 556 Grahamellosis Grahamella, 1109 Haemobartonellosis Haemobartonella, 1102

Melioidosis

Malleomyces, 556

Pseudotuberculosis Pasteurella, 549, 551, 553

Bacterium, 689 Squirrels, ground Tularemia Pasteurella, 569 Water buffaloes Pleuropneumonia, bovine Asterococcus, 1292 Ostcomyclitis Clostridium, 825 Septicemia Chromobacterium, 233 Whales Septicemia Clostridium, 819, 825 Mammals, Scientific Names Acodon serrensis, 1109 Alactaga spp., 1109 Apodemus agrarius, 1108 Aretomys marmota, 1068 Arvicola arralis, 1113 Blarina brevicauda, 1107, 1110 Bos taurus, 1110 Cavia percellus, 1106 Cercopitheeus patas, 1065 Citellus pygmaeus, 1110 Cricetulus spp., 1108, 1110 Cricetus domesticus, 1110 Cricetus phoca, 1111 Ctenodactylus gondi, 1064 Desmodus rufus, 1110 Didelphys aurita, 1066 Didelphys didelphys, 1108 Eliomys quercinus, 1110 Gerbillus tamaricinus, 1110 Glis glis, 1108 Golunda fallax, 1110 Hemiderma brevicauda, 1108 Isodon macrurus, 1003 Jaculus jaculus, 1103 Jerboa sp., 1113 Lutra sp., 1067 Macacus rhesus, 591 Macacus sp., 1101, 1111 Manis pentadactyla, 1108 Maslomys coucha, 1110 Meriones Iristrami, 1004, 1110

Metachirus opossum, 1108

Microtus arralis, 1109, 1110, 1113

Infections Mammals (continued) Shrow (continued) Corumebucterium, 391 Erythrocytes Camela Haemohartonella, 1107 Pseudotuberculosis Sourcel bite Actinomuces, 915 Actinomyces, 974 Chimpanzees Bacillary dysentery Sauirrels Erythrocytes Salmonella, 519 Haemobartanella, 1108 Deer Sourrels, gray Hemorrhagic septicemia Pasteurella, 517 Erythrocytes Haemobartonella, 1107 Domestic animals Squirrels, ground Abortion Bacellus, 669 Brucella, 561, 562 Pasteurella, 549, 551 Abscesses Vole Erythmeytes Tuberculosis Eperuthrosoon, 1133 Grahamella, 1110 Ulcerative lessons Haemobartonella, 1101, 1106 Vole, Field Ferrets Leptospira, 1077 Pasteurella, 552 Water rate Foxes Pasteurella, 551 Listerioses Weasel bate Lasteria, 400 Actinomyces, 973 Paeumonia Whales Streptococcus, 317 Ambergus General. Spirillum, 217 Blue pus Walf Preudomonas, 83 Crythrocytes Cholers Grahamella, 1110 Vibrio, 196 Mammals, Diseases of Conjunctivitis, acute Apes Comunctivitis, granular Infections Noouchia, 503 Streptococcus, 312 Enterocolitus Mabgnant edema Salmonella, 510, 519 Clostridium, 776 Orchstis Bacillus, 826 Spirocharia, 1074 Senticemia Paratitus Spirochaeta, 1074 Gerbilles Syphilis Lastermais Treponema, 1071 Listersa, 100 Trachoma Relapsing fever Chlamydosom, 1114 Spirochaeta, 1003 Beavers Hemorrhagic septicemis hangaroos Gastmenteritie Pasteurella, 331 Huffalore Nocardia, 921 Hemorrhagie septicemia Lungy jaw

Pasteurella, 543, 549

Corynebacterium, 388 Mycobacterium, 879 Corynebactersum, 389 Managaranella, 1119 Streptococcus, 232, 233 Nocardia, 921

et al., Manual, 3rd ed., 1930, 267.) From L. angulatus, referring to the type of lesion produced on the tobacco leaf.

Description taken from Clara (Cornell Agr. Exp. Sta. Mem. 159, 1934, 24).

Rods. 0.75 to 1.5 by 1.5 to 30 microns. Motile by 1 to 6 polar flagella Cramnegative

Gelatin · Liquefaction.

Green fluorescent pigment produced. Beef-extract agar colonies: Dull white,

circular, raised, smooth and glistening. Broth: Turbid in 36 hours and greenish.

Milk Alkaline.

Nitrites not produced from nitrates.

Indole not produced. No H2S produced.

Lipolytic action negative (Starr and Burkholder, Phytopath., \$2, 1942, 601).

Acid but not gas from glucose, galactose, fructose, mannose, arabinose, xylose, sucrose and mannitol. Alkaline reac-- tion from salts of citrie, malie, succinic and tartarie acid. Rhamnose, maltose, lactose, raffinose, glycerol, salicin, and acetie, lactic and formic acids are not fermented.

Starch not hydrolyzed.

Slight growth in broth plus 5 to 6 per cent salt (Burkholder).

Facultative anaerobo.

Distinctive characters: Braun (Phytopath , 27, 1937, 283) considers this species to be identical in culture with Pseudomonas tabaci, but they differ in the type of disease they produce.

Sources: Isolated by Fromme and Murray from small angular leaf spots on

tobace At. Causes the angular leaf spot co (Nicotiana tabacum).

> seudomonas aptata (Brown and on) Stevens. (Bacterium aptatum and Jamicson, Jour. Agr. Res., 1, 206; Phytomonas aptata Bergey et Ianual, 1st ed., 1923, 184; Stevens, by 0.6 to 1.2 missens. Mostle with

06 to 12 microns. Motile with 'gella. Gram-necative.

Green fluorescent pigmeat produced in culture.

Celatia: Liquefaction.

Agar slants: Moderate growth along streak, filiform, whitish, glistening.

Broth: Turbid: A pellicle formed. Milk: Becomes alkaline and clears.

Nitrites not produced from nitrates.

Indole not produced in 10 days Slight propert found later.

No II-S produced.

Acid from glucose, galactose and sucrose. No acid from lactose, maltose and mannitol (Paine and Banfoot, Ann. Appl. Biol., 11, 1924, 312).

Starch not hydrolyzed.

Slight growth in broth plus 7 per cent salt (Burkholder).

Optimum temperature 27° to 28°C. Maximum 34° to 35°C. Minimum below 1°C.

Aerobie.

Source: Isolated from diseased nasturtium leaves from Virginia and diseased beet leaves from Utah.

Habitat: Pathogenic on sugar beets, nasturtiums, and lettuce.

71. Pseudomoaas primulae (Ark and Gardner) Starr and Burkholder. (Phytomonas primulae Ark and Gardner, Phytopath., 26, 1936, 1953; Starr and Burkholder, Phytopath., 52, 1942, 601.) From L. primulus, first; M.L. Primula, a generie name.

Rods: 0.51 to 0.73 by 1.0 to 3 16 microns. Motile with a polar flagellum. Gram-negative.

Green fluorescent pigment produced in culture.

Gelatin: Liquefaction.

Agar colonies: Round, convey, smooth,

glistening, yellowish. Milk: Coagulated.

Nitrites not produced from nitrates. Indole not produced. No HaS produced. Not hpolytic (Starr and Burkholder,

Phytopath., 32, 1942, 601). Acid but not gas from glucose, lactose, sucrose, maltose, galactose, arabinose,

| dammals (continued)                                   | Ristella, 576                                   |
|---|---|
| Microtus montebelli, 1877                             | Streptococcus, 322, 323, 337, 338, 342          |
| Microtus pennsylvanicus pennsylvani-                  | 345   |
| cue, 1105, 1110, 1113                                 | Deer  |
| Mus acomys, 1113                                      | Angiococcus, 1048                               |
| Mus decumanus, 1107, 1110                             | Archangium, 1018                                |
| Mus minutus, 1113                                     | Chandrococcus, 1045, 1046                       |
| Mus musculus, 1110                                    | Chondromyces, 1037, 1038                        |
| Mus norregicus, 1107                                  | Melittangium, 1034                              |
| Mus rattus, 891, 1107, 1110                           | Myzococcus, 1042                                |
| Mus rattus griseiventer, 1107                         | Synangium, 1033                                 |
| Mus sylvatious, 1107                                  | Deer (Antelope)                                 |
| Myoxus glis, 1168                                     | Chondromyces, 1037, 1038                        |
| Peromyseus leucopus novaboracensis,                   | Deer (Roe)                                      |
| 1100, 1108, 1111                                      | Archangium, 1019                                |
| Peromyseus maniculatus, 1111                          | Chandrococcus, 1045                             |
| Peramyseus maniculatus gracilis, 1107,                | Myrococcus, 1042                                |
| 1113  | Deer (Stag)                                     |
| Phodopus praedilectus, 1108                           | Myrococcus, 1042                                |
| Phoga citulina, CSD                                   | Dog   |
| Phyllotis darwini linatus, 1111                       | Bacillus, 815, 820                              |
| Properties anothusii, 1111                            | Myzococeus, 1042                                |
| Pseudocebus apella, 1108                              | Spirochaeta, 1065                               |
| Pteropus, 813, 818                                    | Streptococcus, 337                              |
| Ratius ratius, 1107, 1113                             | Fox   |
| Railus raitus frugeorus, 1107                         |   |
|   | Etreplococcus, 323                              |
| Serurus carolinensis leucotis, 1107                   | Frog<br>Bacillus, 742                           |
| Sciurus sulgaris, 1108, 1113                          |   |
| Spalaz typhtopa, 1101<br>Spermophilus musicus, 669    | General (usually cow) Aerobacter, 456           |
| Thalassochelys caretta, 1111                          |   |
|   | Bacallus, 729, 737, 738                         |
| Vespertilio Luklii, 1979<br>Vespertilio noctula, 1119 | Baclerium, 602, 613, 613, 682, 680              |
| Vesperugo kuhlis, 1670                                | 699, 761  |
| 1 taper ago kantis, 1010                              | Chandramyces, 1037                              |
| Manure (Dung)   | Closifidium, 776, 778, 783, 803, 803            |
| Black cock  | 810, 815, 816, 817, 818, 820, 821, 82           |
| Mycoroccus, 1042                                      | Granulobacter, 826                              |
| Cat   | Muschestering 271, 275                          |
| Streptococcus, 337                                    | Mycobacterium, 890, 891<br>Myzocowa, 1042, 1043 |
| Compost   |   |
| Serratia, 484   | Plectridium, 823<br>Podangium, 1035             |
| Cow   | Polyangium, 1030                                |
| Achramobacter, 423                                    | Pseudomonas, 105, 145                           |
| Bacellus, 815, 821                                    | Sirepiamyces, 910                               |
| Caryophanon, 1001                                     | Goat  |
| Corynebactersum, 403                                  | Chondrocorcus, 1045, 1046                       |
| Viserolactersum, 370, 371                             | Myzecceus, 1012                                 |
| Userococcus, 271                                      | Palangium, 1035                                 |
| Uyeobactersum, 889                                    | Goose   |
| Mprococcus, 1012, 1013                                | Charlesman ton                                  |

Chowleomyces, 1039

| Manure (Dung) (continued)             | Methanobacterium, 646                              |
|---------------------------------------|--|
| Grouse                                | Мухососсия, 1042, 1044                             |
| Chandrococcus, 1045                   | Podangium, 1035                                    |
| Guano                                 | Polyangium, 1026, 1027, 1030, 1031                 |
| Bacillus, 745                         | Sorangium, 1022, 1023                              |
| Guinea pig                            | Synangium, 1033                                    |
| Bacillus, 734, 736                    | Robin  |
| Harc                                  | Bacillus, 756                                      |
| Archangium, 1018, 1019                | Stable   |
| Chondrococcus, 1045, 1047             | Bacillus, 631                                      |
| Polyangium, 1031                      | Steat (Ermine)                                     |
|                                       | Streptococcus, 323                                 |
| Sorangium, 1023                       |  |
| Hen                                   | Mice   |
| Myzococcus, 1042                      | Blind gut  |
| Herbivorous animals                   | Fusiformis, 583                                    |
| Micrococcus, 248                      | Blood  |
| Hog                                   | Bacillus, 647                                      |
| Vibrio, 206                           | Hemophilus, 589                                    |
| Horse                                 | Spirochaeta, 1068                                  |
| Achromobacter, 425, 426               | Spirillum, 215                                     |
| Bacterium, 642, 819                   | Erythrocytes                                       |
| Bacillus, 733, 734, 736, 749, 751     | Dwarf mice   |
| Caduceus, 819                         | Eperythrozoon, 1113                                |
| Chondrococcus, 1045                   | Erythrocytes                                       |
| Clostridium, 783, 799, 810, 813, 814, | Multimammate mice                                  |
| 815 821                               | Grahamella, 1110                                   |
| Flavobacterium, 441, 442, 822         | Erythrocytes                                       |
| Myxococcus, 1012                      | Peruvian mice                                      |
| Podangium, 1035                       | Grahamella, 1111                                   |
| Sorangium, 1023                       | Erythrocytes                                       |
| Streptococcus, 337                    | White mice   |
| Liquid                                | Eperythrozoon, 1112<br>Haemobartonella, 1105, 1106 |
| Sarcina, 290, 291                     |  |
| Spirillum, 216                        | General<br>Bacillus, 816, 817, 825, 826            |
| Vibrio, 204, 206                      | Clostridium, 820, 826                              |
| Mouse                                 | Erysipelothrix, 411                                |
| Mycobacterium, 890                    | Haemobartonella, 1104                              |
| Mycococcus, 1042                      | Pasteurella, 549, 550, 551                         |
| Podangium, 1035                       | Salmonella, 503                                    |
| Mouse, field                          |  |
| Chondrococcus, 1045                   | Lungs<br>Hemophilus, 589                           |
| Muskrat                               | Miyagawanella, 1118                                |
| Angiococcus, 1048                     | Middle ear No'son, 129                             |
| Parrot                                | Middle ear<br>Coccobacillary bodies of Ne'son, 129 |
| Miyagawanella, 1117                   | Spleen   |
| m LLia                                | Hemophilus, 589                                    |
| Archangium, 1018, 1019, 1020          |  |
| Chondrococcus, 1045, 1046             | Mice, Diseases of                                  |
| Chondromyces, 1038                    | Anthrax<br>Bacillus, 720                           |
| Chongromyces, 1034                    | Bacittes,  |
| Melittangium, 1034                    | •  |

| Accordance of Constanting           | Aerobacter, 456, 457                    |
|-------------------------------------|---|
| Mice, Diseases of (continued)       | Alcaligenes, 416                        |
| Bronchopneumonia                    |   |
| Miyagawanella, 1118                 | Aromabacellus, 735                      |
| Cancerous ulcers                    | Bacsilus, 644, 647, 648, 649, 653, 654, |
| Spirochaeta, 1074                   | 660, 662, 668, 672, 712, 717, 721, 726, |
| Cheesy masses in lung               | 730, 731, 733, 734, 736, 737, 738, 741, |
| Corynebactersum, 390                | 742, 743, 744, 745, 746, 748, 751, 752, |
| Epizootic in Japanese waltzing mice | 753, 755, 757, 758, 813, 814, 815,      |
| Bacillus, 751                       | 818, 824                                |
| Gangrene                            | Bacterium, 601, 602, 601, 671, 675,     |
| Streptococcus, 342                  | 679, 680, 681, 681, 687, 760, 761, 762  |
| Joints, infected of white mice      | Brucella, 561                           |
| Corynebacterium, 402                | Chromobacterium, 694                    |
| Mouse typhoid                       | Clostridium, 770, 773, 791, 820, 824    |
| Salmonella, 503                     | Corynebactersum, 390, 406               |
| Plague in field mice                | Escherichia, 447                        |
| Bacterium, 682                      | Flavobactersum, 435, 440, 442, 611      |
| Pleuropneumonia-like disease, 1293  | Galactococcus, 250                      |
| Preumonitis                         | Granulobacillus, 824, 826               |
| Meyagawanella, 1118                 | Lactobacellus, 352, 353, 355, 356, 357, |
| Q (Queensland) fever                | 358, 359, 361, 363, 364                 |
| Cozzella, 1003                      | Leuconostoc, 347, 348                   |
| Septicemia                          | Microbacterium, 371                     |
| Corynebactersum, 390                | Micrococcus, 238, 239, 240, 241, 243,   |
| Septicemia in white mice            | 251, 252, 253, 254, 255, 256, 257, 258, |
| Erystpelothriz, 300                 | 259, 262, 263, 264, 265, 266, 287,      |
| Tuberculosis, avian                 | 208, 273, 274, 278, 279, 280            |
| Mycobactersum, 881                  | Mycobacterium, 879                      |
| Tumors, breast                      | Paraplecirum, 825                       |
| Spirochaeta, 1068                   | Plocamobacterum, 691                    |
| •                                   | Prepronibacterium, 373                  |
| Milk and Cream                      | Pseudomonas, 99, 100, 101, 145, 149,    |
| Cream<br>Bastarian 500              | 170, 700                                |
| Bacterium, 602<br>Leuconostoc, 318  | Sarcina, 290, 292                       |
| Micrococcus, 280                    | Serralia, 481                           |
| Preudomonas, 98, 700                | Streptococcus, 316, 320, 322, 323, 325, |
| Streptococcus, 337, 339, 310, 313   | 326, 327, 328, 331, 335, 336, 337, 339, |
| , bitter                            | 312, 311                                |
| Micrococcus, 263                    | -, curdled                              |
| -, rancid                           | Metrococcus, 262                        |
| . Mcaligenes, 416                   | - restrurized                           |
| , appening                          | Bacellus, 721, 730, 733, 735, 755       |
| Achromobacter, 423                  | Carynebacterium, 496                    |
| Micrococcus, 274, 280               | Lactobacellus, 355, 363                 |
| , 9041                              | Micrococcus, 255                        |
| Flarobacterium, 410                 | Pseudomonas, 101                        |
| Milk                                | - pasteurized chim                      |
| Achromobacter, 421, 423, 425, 427,  | Microsoccus, 255                        |
| (4))                                | -president, we Dairy Products           |
| Acufarrus, 812                      | - raw                                   |
|                                     |   |

Corynebacterium, 300, 400

Actinomyces, 274

Milk and Cream (continued) Walls, damp in mines Milk, red Micrococcus, 255 Sarcina, 293 Walls, wine cellars -, skim Streptococcus, 340 Micrococcus, 237 Mollusca, Common Names -, sterilized Cephaloped Bacillus, 748, 750 Pseudomonas, 112 Vibrio, 202 Mineral Sources Clam, intestine Arrowhead, African Bacterium, 632 Clostridium, 786 General, crystalline atvle Arrowheads, poisoned Cristispira, 1055, 1056, 1057 Bacillus, 826 Mussel Concrete, corresion of Bacillus, 661, 663 Thiobacillus, 81 Cristispira, 1055, 1056, 1057 Coprolite Vibrio, 203, 207 Throbacillus, 80 Oysters Cutting compound Inflabilis, 813 Pseudomonas, 95 Salmonella, 532 Iron ore, swamp Saprospira, 1054, 1055 Siderococcus, 835 Spirillum, 215, 217 Lignite, fossil from -, crystalline style Micrococcus, 266 Cristispira, 1055, 1056 Oil-bearing rocks Scallop Desulfovibrio, 200 Cristispira, 1056 Oil, lubricating Squid, intestine Bacillus, 756 Bacterium, 632 Oil-soaked soils Mollusca, Scientific Names Bacillus, 663 Anodonia cygnea, 1055 Bacterium, 682 Pseudomonas, 95 Anodonia mutabilis, 1055, 1057 Cardium edule, 203, 207 Oil wells Cardium papillasum, 1056 Desulfovibrio, 208 Paint, fresh in greenhouses Chama spp., 1056 Gastrochaena dubia, 1056 Chromobacterium, 233 Lima spp., 1056 Rocks Loligo edulis, 636 Thiobactllus, 80 Loligo pealeit, 632 Rocks, oil-bearing Maetra sulcataria, 1056 Desulfovibrio, 209 Mustelus mustelus, 632 Micrococcus, 271 Mytilus edulis, 661, 663 Salt. see Salt Ostrea edulis, 1056 Salts, Rochelle Ovalipes ocellatus, 632 Micrococcus, 260 Pachalabra moestra, 1056 Tartrate Pecten jacobaeus, 1056 Micrococcus, 260 Pholadis dactyli, 635 Walls, cellar Pinna sp., 1074 Rondelelia minor, 112 Spirochaeta, 1053 Saxicava arctica, 1057 Walls, damp in cellars Sepia ep., 634 Racterium, 688

Micrococcus, 255, 277

Sepiola intermedia, 202

| Solen ensis, 1057 Spheroides maculatus, 632 Tapes decussata, 1057 Tapes laeta, 1058 Venus mercenaria, 632 Venus (Meretris) castra, 1056, 1057   | Mad, lake<br>Leptothriz, 986   |
|---|--|
| Tapes decussata, 1057<br>Tapes taeta, 1056<br>Venus mercenaria, 632   |  |
| Tapes laela, 1056<br>Venus mercenaria, 632  | 17   |
| Tapes laela, 1056<br>Venus mercenaria, 632  | Micromonospora, 979  |
| Venus mercenaria, 632   | Mud, marine  |
| Venus (Meretrix) castra, 1056, 1057   | Achromatium, 999   |
| ,,  | Achromobacter, 418, 419, 421, 425  |
|   | Actinomyces, 970, 972, 974   |
| Mud   | Bacillus, 658, 600, 661, 736, 741, 743,  |
| Aerobacter, 692   | 745, 748, 750, 818   |
| Amoebaeter, 849, 850  | Bacterium, 632   |
| Bacillus, 728, 741, 745, 814, 815   | Clostridium, 795, 820, 821   |
| Chitin-digesting bacteria, 632  | Desulfaciorio, 208   |
| Chlorobium, 870   | Diplococcus, 694   |
| Chlorochromatium, 873   | Flavobacterium, 430, 431, 432  |
| Clathrocysis, 872   | Methanobacterium, 646  |
| Clostridium, 793, 795, 803, 820, 824,   |  |
| 825   | Micrococcus, 696   |
| Cylindrogloca, 874  | Pseudomonas, 108, 697, 698, 699  |
| Lamprocysius, 813   | Spirochaela, 1053  |
| Methanococcus, 218  | Thioptoca, 994   |
| Micrococeus, 258, 275   | Vibrio, 703  |
| Pelochromatium, 850   | Muddy bottom, bmekish waters   |
| Pelodietyon, 871, 872   | Spirillum, 215   |
| Pseudomonas, 698  | Muddy water  |
| Rhabdomonas, 851, 855   | Baeterium, 688   |
|   | Oil, see Mineral Sources   |
| Rhodothece, 855   | Pent   |
| Saresna, 286, 287   | Aetinomyces, 969, 974  |
| Thiobacillus, 78, 79, 81  | Chromobacterium, 234   |
| Thiocapsa, 815  | Hydrogenomonas, 78   |
| Thiocystis, 817   | Throbacellus, 81   |
| Thiolictyon, 816<br>Thiopedia, 813  | Petroleum, see Mineral Sources   |
|   | enotean, see princial bources  |
| ort transference orn  |  |
| Thiopolycoccus, 850   | Pigs, see Hogs   |
| Thiopolycoccus, 850<br>Thiosarcina, 813   | -  |
| Thiopolycoccus, 850<br>Thiosorcina, 813<br>Thiospirillum, 851, 852, 853   | Phosphorescent Bacteria  |
| Thiopolycoccus, 850<br>Thiosarcina, 613<br>Thiospirillum, 851, 852, 853<br>Thiothece, 816   | Phosphorescent Bacteria<br>Achromobacter, 631  |
| Thiopolycocus, 850<br>Thiasarena, 813<br>Thiasprillum, 851, 852, 853<br>Thiobece, 810<br>—, black (fresh, brackishandsalt water)  | Phosphorescent Bacteria<br>Achromobacter, 634<br>Baciilus, 635   |
| Thiopolycoccus, 850 Thusarena, 813 Thiosprillum, 851, 852, 853 Thioblece, 810 —, black (fresh, brackishandsalt water) Methanococcus, 215  | Phosphorescent Bacteria<br>Achromobacter, 631<br>Bacterius, 635<br>Bacterium, 633, 631, 635  |
| Thiopalycoccus, 850 Thiopalycoccus, 853 Thioprillum, 851, 852, 853 Thiobecs, 816 — black (fresh, brackishand salt water) Methanococcus, 218 Steplococcus, 357   | Phosphorescent Bacteria<br>Achromobacter, G31<br>Bactilus, G35<br>Bacterium, G33, G31, G35<br>Pseudomonas, 111, 112, 147   |
| Thiopolycoccus, 850 Theoretia, 851, 852, 853 Thioprellium, 851, 852, 853 Thiolocc, 816 — black (fresh, brackish and salt water) Methanococcus, 215 Streptococcus, 357 Urobacterium, 601   | Phosphorescent Bacteria<br>Achromobacter, 631<br>Bacterius, 635<br>Bacterium, 633, 631, 635  |
| Thiopolycoccus, 850 Theorema, 813 Thioperillum, 851, 852, 853 Thothere, 816 - black (fresh, brackish and salt water) Methamococcus, 218 Stephococcus, 357 Urobacterum, 691 - canal  | Phosphorescent Bacteria<br>Achtmodacter, 635<br>Bacterium, 635, 631, 635<br>Bacterium, 633, 631, 635<br>Feeudomenas, 111, 112, 147<br>Sarcina, 637<br>Vibrio, 203  |
| Thiopolycoccus, 850 Theorema, 813 Thioperillum, 851, 852, 853 Thothere, 816 - black (fresh, brackish and salt water) Methamococcus, 218 Stephococcus, 357 Urobacterum, 691 - canal  | Phosphorestent Barteria Achrimobacter, 531 Bactive, 532 Bacterium, 633, 631, 635 Petudomomas, 111, 112, 147 Sarcina, 637 'Isbro, 293 Phosphorescent Materials  |
| Thiopolycoccus, 850 Theoretium, 851, 852, 853 Thioprillum, 851, 852, 853 Thiothece, 816 - black (fresh, brackish, and salt water) Methancoccus, 216 Steplococcus, 357 Urobacterium, 691 - canal Methanobacterium, 616   | Phosphorescent Bacteria Achrimolacter, 031 Bacterium, 635 Bacterium, 633, 631, 635 Pseudomomos, 111, 112, 147 Sarcina, 637 Vibro, 203 Phosphorescent Materials Amphipod, drad, 111   |
| Thiopolycoccus, 850 Theoperena, 813 Thiopperillum, 851, 852, 853 Thoobeec, 816 Thoobeec, 816 Theoperillum, 851, 852, 853 Thoobeec, 815 Ifethanococcus, 215 Stephococcus, 357 Urobactersum, 801 — canal Methanobactersum, 616 — containing sullur  | Phosphorestent Batteria Acht modulet, 531 Bactive, 532 Bacterium, 533, 531, 635 Peteudomonous, 111, 112, 147 Surena, 637 Tubro, 293 Phosphorescent Materials Amphipod, drad, 111 Freah water altrimp, 636  |
| Thiopalycoccus, 830 Thioparcina, 813 Thioparcillum, 831, 852, 853 Thiothece, 816 - black (fresh, brackish and salt water) Methanococcus, 257 Methanococcus, 257 Urobacterium, 691 - canal Methanobacterium, 616 - containing sullur Achematium, 999   | Phosphorestent Barteria Achromolacter, 035 Bacterium, 635, 635 Bacterium, 633, 635 Peeudomenus, 111, 112, 147 Sareina, 637 Fibro, 203 Phosphorescent Materials Amplipod, drad, 111 Fresh water shrimp, 636 General, 702, 703   |
| Thiopalyoccus, 850 Thioparona, 813 Thioparona, 813 Thioparolan, 851, 852, 853 Thothece, 816 - black (fresh, brackish and salt water) Methanococcus, 215 Stephococcus, 357 Urobactersum, 601 - canal Methanobactersum, 616 - containing sullur Achromatium, 999 Actinomyces, 973 Macromonas, 1001 Thioploca, 991 | Phosphorestent Batteria Acht modulet, 531 Bactive, 532 Bacterium, 533, 531, 635 Peteudomonous, 111, 112, 147 Surena, 637 Tubro, 293 Phosphorescent Materials Amphipod, drad, 111 Freah water altrimp, 636  |
| Thiopalycocus, 820 Thioparcusa, 833 Thioparcillum, 831, 852, 853 Thiobece, 816 - black (fresh, brackish and salt water) Methanococcus, 235 Steplococcus, 337 Urobacterium, 601 - canal Methanobacterium, 616 - containing sullur Achematium, 920 Actinomyces, 973 Macromona, 1001                               | Phosphorescent Bacteria Achtemodacter, 531 Bactitus, 531 Bacterium, 535, 531, 635 Bacterium, 535, 531, 635 Pecudomonacs, 111, 112, 147 Surena, 637 Yishro, 203 Phosphorescent Materials Ampulipod, dend, 111 Freah water alrimp, 636 General, 702, 703 Luminous cephalopod, 112, 202 |

Plant Disease Attacking Acer macrophilum, 113 Acer 8pp., 113, 165 Aesculus turbinata, 165 Agaricus campestria, 123, 129 Agropuron repens, 116 Agropyron smithii, 395 Aleuritis fords, 131 Allium cepa, 136, 146, 740 Amaranthus spp., 178 Amorphophallus knoiac, 171 Ananas comosus, 127, 128 Ananas sativus, 472 Antierhinum majus, 167 Apium oraveolens, 122 Arctium lappa, 168 Aster chinensis, 477, 738 Astragalus ap., 139 Arena satica, 113, 116 Arena spp., 162, 163 Begonia spp., 155 Berberis thunbergerii, 116 Berberts vulgaris, 116, 155 Beta vulgaris, 144, 468, 478, 613, 639, 663 Bowlesia septentrionalis, 125 Brassica rapa, 136 Bromus inermis, 116 Calendula officinalis, 133 Canna indica, 171 Capsicum annum, 164, 740 Capsicum spp. 120 Carnegica gigantea, 468 Castanea spp. 138 Chaetochloa lutescens, 142 Cichorium intubus, 125, 134 Cicharium spp., 133, 134 Cissus japonica, 134 Citrus spp., 156, 178 Coffea arabica, 639 Corchorus capsularis, 164 Corylus colurna, 139 Corvlus, spp., 157 Cucumis sativus, 117 Curcurbitaceae, 468 Cuminum spp., 121 Dactylte glomerata, 391 Dahlia sp , 473 Daucus carola, 136 Daucus carota var. satira, 166 Delphinium spp., 115, 134, 696

Dandrobium sp., 613 Dianthus caryophyllus, 137, 143 Dianthus sp., 639 Dieffenbachia picta, 157 Dolichos lablab, 160 Dracaena fragrans, 157 Edgeworthia chrysantha, 478 Eriobotrya japonica, 144 Erodium texanum, 122 Eugenia latifolia, 399 Euphorbia pulcherrima, 399 Frazinus spp., 132 Gardenia jasminoides, 136, 696 Geranium spp., 160, 167 Gladiolus spp., 118, 130, 168, 478 Glycine maz, 131, 132 Glycine sp., 160, 161 Gossypium spp., 160 Gosspium sp., 471, 477, 745 Gypsophila paniculata, 230 Hedera heliz, 166 Helianthus debilis, 141 Holeus sorghum, 143, 754 Holeus spp., 158 Hordeum vulgare, 113, 116, 162, 163, 740 Hyacinthus orientalis, 152 Ipomoca batatas, 136, 739 Iris app , 118, 140, 147, 639 Juglans spp., 159 Koelranteria paniculata, 165 Lactuca sativa, 114, 115, 125, 126, 129, 134, 153, 154, 746 Lactuca sativa var. angustata, 163 Lactuca scariola, 154 Lathurus odoratus, 477 Lens esculenta, 141 Lespedeza spp., 159 Levisticum officiale, 141 Ligustrum japonicum, 128 Lupinus polyphillus, 160 Lapinus sp . 747 Luchnis sp., 639 Lycopersicon esculentum, 145, 164, 747, Lycopersicon lycopersicum, 112, 138 Mangifera indica, 475 Maniholus sp., 466 Maniholus utilissima, 170 Martynia louisiana, 112 Matthiola incana, 158

Plant Disesse Attacking (continued) Soja max, 131, 132 Matthiola incana var. annua, 122 Solanum tuberosum, 129, 138, 757 Medicago sativa, 165, 393 Stizolobium deeringianium, 135 Medicago sp., 118 Taraxacum kol-saghz, 179 Milletia floribunda, 466 Thea sinensis, 756 Morus ap , 135 \* Trifolium pratense, 141 Musa saprentum, 140, 169 Trifolium spp , 757 Nerium oleander, 133 Triticum aestivum, 116, 121, 400 Nicotiana tabacum, 114, 124, 127, 130, Triticum sp , 162, 163, 740 138, 167 Ulmus sp., 142, 472 Odontoglossum citrosmum, 751 l'iburnum spp , 135 Olea sp., 132 Vicia faba, 136, 139 Oncidium krameriani, 145 Vigna sinensis, 703 Oncidium sp , 640 Vigna sp , 160 Oryza sativa, 169 Vilia sp., 145, 276, 466, 478, 758 Panax quinquefolium, 131 Vetis vinifera, 639 Panicum miliaceum, 144, 169 Washingtonia filifera, 697 Papater rhocas, 165 Zea mays, 472 Passiflora edulis, 138 Zingibar officinale, 171 Pelargonium epp , 122, 160 Plant Diseases Petasites japonicus, 142 Alfalfa Petasites sp , 142 Leaves of, 165 Phaseolus vulgaris, 119, 127, 131, 160, Stem and leaves, brown lesions, 118 161, 747 Vascular pathogen, 393 Phleum pratense, 703 Aloes, 758 Phormium tenaz, 166 .1maranthus, 178 Pinus halepensis, 640 Antierhinum Piper betle, 130 Leaf spot, 167 Pisum sativum, 119, 138, 747 Apples Pisum satirum var. arcense, 119 Blister spot, 697 Plantago lanceolata, 161 Blisters and rough bark, 121 l'olygonum convolvulus, 140 Canker, 610 Populus app , 123, 751 Fire blight, 465 Primula polyantha, 114, 115 Harry root of, 229 Primula spp , 114 Rot of, 141 Protea eynaroides, 170 Apricots, 153 Prunus \*pp., 123, 153 Arrownood Pseudotsuga taxifolia, 231 Angular leaf spot and stem lesions. Pueraria hirauta, 119 Rhododendron ferrugineum, 639 Ash Ricinus communis, 131, 162 Cankers, 132 Rosaceae, 465 Asparagus lettuce Rubus app , 229 Leaf spot on, 168 Saceharum oficinarum, 121, 121, 163, Aster, 477 171, 472, 473, 639, 753 Aster, China, 738 Salız alba, 467 Astragulus Salız spp., 144, 746 Black leaf spot, 139 Saponana, 639 Seeale cereale, 116, 162, 168, 740

Rananas, 613

Black rot, 140

Blood disease of, 169

Scsamum, 753

Setaria stalica, 126

| Plant Diseases (continued)     |                                      |
|--------------------------------|--------------------------------------|
| Barberry                       | Canna                                |
| Leaves and twigs, 116          | Leaves, 17                           |
| Barley, 116, 740               | Cantaloupes                          |
| Leaf streak, 113               | Wilt, 468                            |
| Tourse and send at 100 100     | Carnations                           |
| Leaves and seed of, 162, 163   | Leaves, 640                          |
| Bean 120, 131, 160, 161, 341   | Root and stalk disease, 137          |
| Blighted leaves and stems, 127 | Water-soaked lesions and leaves, 143 |
| Halo blight, 119               | Carrots, 136                         |
| Wilt, 399                      | Leaves, 166                          |
| Bean, Broad, 136, 139          | Rot, 468                             |
| Castor oil, 131                | Soft rot, 471                        |
| Leaf spot, 162                 | Cassava                              |
| Hyacinth, 160                  | Necrotic lesions of leaves, 466      |
| Kidney, 747                    | Wilt disease, 170                    |
| Soy, 131, 132, 160, 161        | Cauliflower                          |
| Spotted, 127                   | Black rot of, 155, 156               |
| Velvet                         | Leaves, 117                          |
| Leaf spot, 135                 | Soft rot, 474                        |
| Windsor, 136, 139              | Celery                               |
| Bedts ·                        | Leaves, 122                          |
| Gall on, 154                   | Rot, 639                             |
| Leaves, 114                    | Soft rot, 471                        |
| Vascular rot, 144              | Cherries, 120                        |
| Beets, Sugar                   | Chestnut                             |
| Gall on, 154                   | Canker, 640                          |
| Begonia                        | Water-soaked spots on leaves, 133    |
| Leaf spot, 155                 | Chrysanthemum                        |
| Betel vine                     | Fasciated growth, 395                |
| Leaf spot, 130                 | Citrus, 120                          |
| Bindweed, Black                | Canker of, 156                       |
| Diseased leaves, 140           | Citrus fruits                        |
| Bird's nest fern               | Spot disease, 475                    |
| Leaf blight, 696               | Clover, 757                          |
| Blackberries, 229              | Clover, red                          |
| Bowlesia                       | Root rot, 141                        |
| Water-soaked spots of, 125     | Corn, Field                          |
| Brome-grass                    | Blight, 457                          |
| Water-soaked spots, 116        | Stalk rot, 124, 125, 472             |
| Broom corn                     | Cotton, 477                          |
| Lesions, 143                   | Angular leaf spot, 160               |
| Burdock                        | Boll rot, 745                        |
| Leaves and petioles of, 168    | Root rot, 471                        |
| Cabbage, 117                   | Stem and boll lesions, 10            |
| Black rot, 155, 156            | Cow peas, 120, 161, 703              |
| Soft rot, 471, 474, 477        | Cricket bat willow                   |
| Cactus, 613                    | Watermark disease, 46"               |
| Rot, 477                       | Cucumber                             |
| Calla lily                     | Leaves, 117                          |
| Cath and 474                   | Soft rot, 471, 474                   |

Plant Diseases (continued) Cucumber (confinued) Wilt, 468 Cumin Blighted, 121 Dactylis glomerata Slimy beads, 394 Dilitia Tuber and stem rot, 473 Delphinium Black spot on leaves, 115 Douglas fir Galls on, 231 Dill Blighted, 121 Fee Plant Soft rot, 471, 474 Elms. 279 Dark discoloration of wood, 142 Wet mood, 472 English walnut Black spot of leaves and nut, 159 Eugenta latifolia Witches'-broom, 399 Blight, 610 Filbert trees, 157, 640 Leaf stripes, 166 Foxtail, 142 French endive Rot, 125, 134 Gardenias, 696 General, 89, 344 Loaf spot, 136 Geranium Fasciated growth, 395 Galls on, 228, 229, 230, 231 General, 167 Leaf apot, 160 Guant cactus Rot, 468 Ginger Sprout ret, 171 Ginseng Root rot, 131, 477 Gladiolus, 118, 478 Gummy lesions on leaves, 168 Tubers, corm rot, 130 Grapes, 145, 466, 478, 637, 758 Grapevines, 276

Grasses, 142 Harelaut, Turkish Leaves and stems of, 139 Hemn's bill Leaf stat, 122 Horse-radish, 164 Black rot of, 155, 156 Root tot. 477 Hyacinth Soft rot, 471 Yellow rot, 152 Iris, 118, 140, 147 Blight on leaves, 639 Brown leaf spot, 140 Soft rot, 177, 471 Italian millet Brown stripe, 320 Yvy Leaves, 166 Ivy, Japanese Black spot on leaves, 134 Johnson's grass Leaf stripe, 171 Jute Water-scaled to brown spots on leaves, 164 Konnac, 171 Kudzu vine Halo blight, 119 Larkspur Bacteral blight, 696 Rot. 131 Lentils Root rot, 141 Lettuce, 151, 158, 746 Leaves, 114, 115 Marginal lesions, 126 Root disease, 129 Rosette discare, 129 Rot, 125, 131 Lettuce, wild, 151 Labe. 120 Lily Brown spots on bulbs, 477 Logust Bud rot, 144 Lorare Epot on leaves, 141 Lucerne Root rot, 141

| Plant Diseases (continued)                    | Peas, field   |
|---|---|
| Lupine, 161, 747                              | Water-soaked lesions, 119   |
| Maize, see Corn                               | -, garden   |
| Mango, 475                                    | Water-soaked lesions, 119   |
| Maple   | Pelargonium   |
| Leaves, 165                                   | Leaf spot, 160  |
| Maple, large leaf                             | Peppers, 120  |
| Leaves, 113                                   | Leaf wilt, 740  |
| Marigolds, 133                                | Soft rot, 471   |
| Millet  | Spotted fruit, 16f  |
| Leaf stripe, 144                              | Petunia   |
| Leaves, sheaths and culms, 169                | Fasciated growth, 395   |
|   | Pine  |
| Mulberry                                      | Galls, 640  |
| Blight, 135                                   | Pineapples  |
| Mushrooms, cultivated                         | Brown rot, 473  |
| Brown spots on, 128                           | Rot, 127, 128   |
| Muskmelon                                     |   |
| Soft rot, 471                                 | Plantago spp.   |
| Wilt, 468                                     | Leaves, 161   |
| Nasturtium                                    | Plum  |
| Leaves, 114                                   | Cankers, 123  |
| Oats  | Plum, Japanese, 153   |
| Black chaff, 162, 163                         | Poinsettia<br>Canker of stems and leaf spots, 39                  |
| Galls, 133                                    | Canker of stems and test speed                                    |
| Halo spot, 116                                | Poplar  |
| Leaf blight, 116                              | Cankers, 123  |
| Leaf streak, 113                              | Galls on branches, 751  |
| Olive, 761                                    | Poppy hude and pois   |
| Galis and tubercles, 132, 750                 | Poppy<br>Black spots on leaves, buds and pods                     |
| Onions, 740                                   | 165   |
| Bulb rot, 136, 146                            | Potatoes  |
| Rot, 146                                      | Black leg, 469  |
| Soft rot, 471                                 | Black rot of stem and tuber, 469                                  |
| Orange  | Blight and rot, 312   |
| Canker of, 156                                | Brown rot, 138  |
| Orchid, 145, 640, 759                         | Dark colored stem, 968  |
| Penama 478                                    | Dry rot, 259  |
| Papaya, 478                                   | Leaves, 757   |
| Paris daisy                                   | Wing yest, 393  |
| Galls, 228                                    |   |
| Parsnip<br>Soft rot, 471, 474                 | Rot, 129, 138, 203, 405<br>Scab 958, 968, 969, 970, 971, 972, 973 |
| Solt rot, 411, 412                            | 071   |
| Passion fruit 138                             | Soft rot, 471, 474, 477   |
| Leaves and fruit, 138                         | Tubers, 640   |
| Peaches, 153                                  |   |
| Pear 120 130 134                              | Primrose<br>Leaf spot, 114, 115                                   |
| Pear Blossom blight, 129, 130, 134            | Privet, Japanese, 128   |
| Canker, 640                                   | Privet, Japanese,   |
| Fire blight, 465                              | Proso millet<br>Leaves, sheaths and culms, 169                    |
| Peas, 747 Diseased seeds, stems and pods, 138 | Leaves, sucation  |

glycerol, dulcitol and mannitol. Starch not hydrolyzed.

Crowth in broth plus 5 per cent salt. 'Optimum temperature 19° to 22°C.

Maximum 34°C. Minimum 10°C. Optimum pH 68 to 7.0. Minimum 4.5 to 5 0.

Facultativo anaerobe.

Source: Isolated from leaf-spot of Primula polyantha

Habitat: Pathogenic on Primula spp.

72. Pseudomonas viridilivida (Brown) Holland (Bacterium viridilividum Brown, Jour. Agr. Res. 4, 1915, 475; Holland, Jour. Bact., 5, 1920, 225; Phytomonas uridilwida Bergev et al . Manual, 1st ed., 1923, 187 ) From Latin, viridis, green; Iwidus, blue.

Rods: 1,0 to 1,25 by 1 25 to 3 0 microns Motile with 1 to 3 polar flagella Cram-

negative. Creen fluorescent pigment produced in culture.

Gelatin: Slow liquefaction

Beci agar colonics: Cream white, round, smooth, translucent, edges entire

Broth: Turbid, becomes lime green Milk: Alkaline and elears.

Nitrites not produced from nitrates Indole is produced.

Not lipolytic (Starr and Burkbolder, Phytopath., 32, 1912, 601).

Acid from glucose and aucrose (Burkholder).

Grous well in 4.5 per cent salt. Grous in 7 per cent salt (Burkholder). Mini-

Maximum temperature 31.5°C. mum 15°C

Acrobic.

Source: Isolated from diseased lettuce from Louisiana.

Habitat: Pathogenic on lettuce, Lacluca satira.

73. Pseudomonas delphiali (Smith) Stapp (Bacillus delphini Smith. Seience, 19, 1901, 117; Bacterium delphinii Bryan, Jour. Agr. Res., 29, 1921, 201; Stapp, in Sorauer, Handbuch der Pflanzenkrankheiten, 2, 5 Auf., 1928, 106;

Phytomonas delphinii Bergey et al., Manual, 3rd ed., 1930, 261.) From Latin, delphin, a dolphin; M.L. Delphinium, a generic name,

Rods: 0.6 to 0.8 by 1.5 to 20 microns. Chains present. Motile with I to 6 polar flagella, Capsules, Gram-negative,

Green fluorescent pigment produced in culture.

Gelatin: Liquified.

Reef agar slants. Growth thin, smooth, shining, transparent, margins entire, ervstals. Agar becomes dark brown. Broth: Turbid in 24 hours with delicate

pellicle.

Milk . Becomes alkaline and clears. Nitrites not produced from nitrates Indole not produced.

No II S produced.

Lipolytic action negative (Starr and Burkholder, Phytopath., 32, 1912, 601). Acid from glucose, galactoso and fructose: slightly acid from sucrose. No acid from lactose, maltoso, glycerol and mannitol.

Starch. Hydrolysis feeble.

Weak growth in broth plus 4 per cent

Optimum pH 6.7 to 7.1. pH range 5.0 to S G

Optimum temperature 25°C. Maximum 30°C. Minimum I°C or less. Source: Isolated from black snot of

delphinum.

Habitat: Pathogenic on delphinium causing a black spot in the leaves.

74. Pseudomonas berberidis (Thornberry and Anderson) Stapp. (Phylomonas berberidis Thornberry and Anderson, Jour. Agr Res , 45, 1931, 36; Stapp, Bot. Rev., 1, 1935, 407, Bacterium berberidis Burgwitz, Phytopathogenic Bicteria, Leningrad, 1935, 153.) From M.L. Berberis, barberry, generic name.

Rods : 0 5 to 1.0 by 1.5 to 2.5 microus, occurring singly or in pairs. Motile with 2 to 4 polar flagella Capsules present.

Gram-negative (Burkholder): Gram positive as stated in original deecription.

Plant Diseases (continued) Wisteria Canker, 640 Wisteria, Japanese,

Gall, 466 Plant Sources

Abri precatorii, 672 Alepecurus pratensis, 738 Algae, 218, 366

Almus spp., 944, 968 Aquatic plants, 672

Arachis hypogasa, 681 Asparagus infusions, 262

Aucuba japonica, 146 Bark, covered with lichens, 1035

Bark, decaying, 1012

Bark, old, 1045 Bark, poplar, 1026, 1031

Bark, wet, 1026, 1030

Barley, 679 Bean infusions, 218, 262, 264, 263, 271,

273, 277, 750 Beans, purple discoloration salted, 109

Beer wort, 146 Beet juice, 657

Beet juice, fernented, 189

Beets, 825

Fodder, 100 Leaves, 752 Rotting, 250

Bladderwort, 671

Boleius edulis, 254 Brewer's grain, 744

Cabbage, 456, 750 Cacao beans, 951

Carrot, slices of, 758 Cherry trees, gum, 754

Cladophora, 1032 Clematis, stem of, 1042

Corn, 759, 760, 761, 781, 825

Grains soaked in water, 148 Seedlings, 281

Stalks, 825 Cotton husks, 222

Decaying vegetation, 989 Decomposing leaves, 618 Digitalis infusions, 262, 263

Elodea, leaves, 239, 833 Epiphytes, 833, 834

Flax, retting, 803, 807, 814, 819, 822 823, 824

Flour, 281, 291, 292, 293, 294 Flour pastes, acidified, 287

Fodder, 733, 737, 750, 755 Green, 750, 755

Fruits, 694 Fungi, 254, 689 Fungi, old, 1037

General, 455, 712, 717

Grains, 281, 455, 460, 602, 654, 721, 751, 774, 824, 825, 826, 916, 935, 967, 968,

969, 970 Grains, ground, 733, 736, 751

Grapes, Spanish dried, 624 Grapes stored in sawdust, 756

Grass, 370, 749, 973 Green algae, fresh water, 834

Hay, 602, 734, 740, 890, 957 Clover, 173

Heating of, 740 Hevea brasiliensis, 256, 260, 273, 281,

Hibiscus, Retting, 263, 813, 615, 819 Hibiscus, stamens and pistils of, 258

Ipomoea sp., 949, 958 Jequirity seed, 672

Kelp, 970 Kenaf, retting of, 263, 813, 815, 819

Latex, 256, 260, 273, 281, 416 Lathyrus spp., 225

Leaves, 173, 1046 Indigo plant, 659

Pitcher plant, 655, 668

Sundaw, 653 Legumes, 824 Lens spp., 225

Lichens, 1045 Decaying, 1031

Litmus solution, 743, 757

Liverworts, 1020

Lupine, 226, 656, 657, 661, 663, 678, 689

Maize, see Corn Maple sap, 664

Slimy, 450 Marine algae, 200, 627, 642, 692, 697,

608, 702, 703, 1016 Acanthophora spicifera, 703 Cladophoropsis sp., 702

Gracilaria blodgettii, 697 Gracilaria conferendes, 702, 703 Iridaea cordata, 629, 630

| Plant Diseases (continued)           | Soft rot, 472, 473                 |
|--------------------------------------|------------------------------------|
| Protea                               | Stalk rot, 121, 125                |
| Leaf spot, 170                       | Stinking rot, 121                  |
| Pumpkin                              | White stripe, 630                  |
| Wilt, 468                            | Sunflower, 141                     |
| Radishea                             | Sweet peas, 477                    |
| Leaf spot, 164                       | Fasciated growth, 395              |
| Rot, 468                             | Sweet potato, 138, 949, 958        |
| Soft rot, 471, 474                   | Rot, 739                           |
| Raspberries, 229                     | Tea, 756                           |
| Galls on canes, 220                  | Timothy grass                      |
| Rhubarb                              | Streak disease, 703                |
| Crown rot, 476                       | Tobacco, 167, 477                  |
| Rice                                 | Angular leaf spot, 114             |
| Leaf blight, 169                     | Black rust, 124                    |
| Russian dandelion                    | Brown rot, 137, 138                |
| Root rot, 179                        |                                    |
|                                      | Collar rot, 477                    |
| Rutabagas                            | Fasciated growth, 395              |
| Black rot of, 155, 156               | Leaf spot, 127, 477, 639           |
| Ryc, 740                             | Rusty spot on leaves, 130          |
| Black chaff, 162, 163                | Wildfire, 121                      |
| Leaf blight, 116                     | Tomatoes, 747, 757                 |
| Salarly                              | Bacterial canker, 394              |
| Soft rot, 474                        | Blossem end rot, 477               |
| Sesame, 753                          | Brown rot, 138                     |
| Brown spots on leaves and stems, 128 | Leaves, II3                        |
| Soft rots, 640                       | Rot, 468, 640                      |
| Solanaceous plants                   | Soft rot, 471, 474                 |
| Brown rot, 137, 138                  | Spotted fruits, 164                |
| Sorghum, 754                         | Tung oil tree, 131                 |
| Lesi stripe, 171                     | Turnips, 136                       |
| Lesions, 143                         | Leaf spots, 161                    |
| Rot, 750                             | Soft rot, 471, 474                 |
| Streak disease of leaves, 158        | Unicorn plant                      |
| Sorgo                                | Leaves, 112                        |
| Lesions, 143                         | Vanilla vinc, 610                  |
| Squash                               | Walnut                             |
| Leaf spot, 157                       | Black spot of leaves and nuts, 150 |
| Walt, 468                            | Washington palm, 697               |
| Stock, flowering, 158                | Wheat, 279, 639                    |
| Vascular disease, 122                | Basal glume rot, 121               |
| Sugar beet, 114, 477, 639            | Black chaff of, 162, 163           |
| Curly top, 663                       | Leaf blight, 116                   |
| Rot, 468                             | Slimy heads, 400                   |
| Soft rot, 613                        | Wheat grass                        |
| Sugar cane                           |                                    |
| Bacterial gummosis, 163              | Slumy heads, 395                   |
| Leaf scald, 639                      | Willow, 746                        |
| Mottled stripe, 170                  | Wilted branches, 141               |
| Red stripe, 151                      | Winter eress                       |
| Fereh, 753                           | Black rot of leaves and atems, 155 |
|                                      |                                    |

| Protozoa, Scientific Names   |                                       |
|--|---------------------------------------|
| Descovina spp., 583  | Diplococcus, 309                      |
| Devescovina hilli, 1075  | Micrococcus, 256                      |
|  | Proleus, 488, 489                     |
| Euglena desce, 1121  | Risiella, 576                         |
| Lophomonas striata, 694  | Meat infusions                        |
| Paramoecium aurelia, 1122  | Micrococcus, 254                      |
| Paramoecium caudatum, 1122   | -, luminous, 633, 635                 |
| Pelomyxa palustris, 1123   | Milk                                  |
| Polymastix legeri, 694   | Bacillus, 824                         |
| Polymastix melolonthae, 694  | Pork, macerated                       |
| Trichomonas batrachorum, 1123  | Clostridium, 783, 802                 |
| Trichonympha chattoni, 1121  | Sulfur stinker spoilage, canned goods |
| Trichonympha corbula, 1121   | Clostridium, 803                      |
| Trichonympha peplophora, 1121  | 2                                     |
| Trichonympha spp , 1121  | Rabbits                               |
| Putrefying Materials   | Blood                                 |
| Blood  | Bacillus, 818                         |
|  | Spirochaeta, 1069                     |
| Bacillus, 817  | Brain                                 |
| Streptococcus, 340, 341, 343, 344                                    | Flavobacterium, 437                   |
| Bones, macerated   | Erythrocytes                          |
| Bacterium, 683   | Eperythrazoon, 1113                   |
| Eggs, rotten   | Eye, Descemet's membrane              |
| Bacillus, 657  | Rickettsia, 1991                      |
| Egg white  | -, endothelial cells                  |
| Bacillus, 654  |                                       |
| Fish   | Rickettsia, 1091                      |
| Bacillus, 671, 814   | General 971                           |
| Clostridium, 821   | Micrococcus, 271                      |
| , luminous   | Salmonella, 513, 514, 521             |
| Bacterium, 633, 634, 635, 636, 637                                   | Streptococcus, 339, 339               |
| - spoiled semi-dried   | Verilonella, 304                      |
| Flavobacterium, 694  | Kidney 105                            |
| Game birds   | Corynebacterium, 405                  |
| Bacillus, 817  | Liver                                 |
| Clostridium, 796   | Spirochacta, 1065                     |
| Gelatin, spoiled   | Lungs                                 |
| Bacellus, 756  | Bacillus, 647                         |
| General  | Mouth cavity                          |
| Bacterium, 607, 608, 609, 610  | Veillonella, 303                      |
| Pseudomonas, 97  | Nasal mucosa                          |
| Spirillum, 214, 216, 217   | Zuberella, 578                        |
| Streptococcus, 330   | Not pathogenic for                    |
|  | Johne's disease                       |
| Ham, sour<br>Clostridium, 784  | Mycobactersum, 881                    |
|  | Tuberculosis, amphibian               |
| Infusions  | Mycobacterium, 885                    |
| Bacillus, 816  | Tuberculosis, bovine                  |
| Manure, see Manure (Dung)  | Mycobacterium, 879                    |
| Ment 010 PIC 818 825   | Tuberculosis, human                   |
| Bacellus, 813, 816, 818, 825<br>Clostridium, 788, 796, 800, 821, 826 | Mycobacterium, 878                    |

Plant Sources (continued) Roots of alder, 944, 968 Marine algae (continued) Roots of Myrica, 972 Laurencia poitei, 702 Rotting vegetables, 654 Nercocustis luctheana, 629, 630 Rotting wood, 145, 211 Odonthalia kamischatica, 628 Rubber tree, late v of, 256, 260, 273, 284 Porphyra perforata, 630 Santtaria, 833 Marine phytoplankton, 421, 703 Salvinia, 833 Meadow plants, 749 Sauerkraut, 146 Meal, cotton seed, 689 Saw dust, 210, 211 Medicago app., 227 Scawced, see Marine Algae Melilotus app., 227 Rotting, 680 Melon rind, 1037 Seeds, germinating, 678, 679 Murica, 972 Serradella app., 226 Nodules on roots of Snakeroot infusions, 263 Alfalfa, 227 Soja max (Glycine max), 226, 202 Beans, 225 Sorghum, 253 Clover, 226, 489 Soybean mash, 292 Coffee, 633 Sphagnum moss, 344 For grass, 738 Legumes, 650, 650, 657, 661, 663, 678, Spirogura sp., 834 Straw, 271, 602, 935, 080 Lentals, 225 Old, 1037 Strawberries, 422 Lupine, 226 Sugar beet, 748 Pea, 225 Sugar cane, roots, 825 Soybeans, 226 Sweet clover, 227 Surfaces, 484 Vetch, 225 Timothy grass, 800 Numphaca, 833 Tobacco, 674, 677, 680, 682, 683, 685, 636, 687, 600, 601 Oranges, 825 Oranthopus upp , 226 Tomato juice, 713 Pararubber tree, 416 Rotted, 491 Parasitic on lichens, 1035 Trifolium spp., 226 Triconella spp , 227 Peanut plant, 681, 690 Peas, 751 Utrieularia vulgaris, 671 Pelargonium, 167 Vegetable fibers, disintegrating, 210 Persummons, dried, 679, 694 Vegetable infusions, 147, 148, 277, 278, 280 Phaseolus app., 225 Pine bark, 677 Vicia app., 225 Plant dust, 889 Watermelon, decayed, 748 Wheat bran, 287 Poison ivy, 279 Poison on arrowheads, \$26 Wood, old, 1037 Poplar trees, bark, 259, 272 Rotting, 728, 736, 745, 747, 758, 1037 Polamogeton natons, 534 Wet, 1026, 1030 Potators, 201, 209, 781, 825 Yeast mash, 146 Internal rust spots, 95 Zoster marina, 1002 Hotten, 491, 738, 1074 Rhus epp , 279 Poultry Diseases, see Birds Rice, 825

Protozoa, Common Names

Fingeliste cetoparasite

Funformia, 583

Treponena, 1075

Hulls, 222

ete

Paddies, C76

Root nodules, see Nodules on legumes,

|                                   | • 1   |
|-----------------------------------|---|
| Rats (continued)                  | Glanders  |
| Erythrocytes                      | Malleomyces, 556                                  |
| Grahamella, 1110                  | Hemorrhagic septicemia                            |
| Ilaemobartonella, 1107, 1108      | Pariamella 519 510 550 551                        |
| -, albino                         | Pasieurella, 548, 549, 550, 551<br>Hepatized Jung |
| Ilaemobartonella, 1103            |   |
| -, jumping                        | Bacterium, 402                                    |
| Grahamella, 1110                  | Leprosy   |
| -, marsupial                      | Mycobacterium, 882                                |
| Haemobartonella, 1108             | Melioidosis                                       |
| -, white                          | Malleomyces, 556                                  |
|                                   | Nodular lesions, Madagascar rat                   |
| Hacmobarionella, 1106             | Actinomyces, 917                                  |
| Feces                             | Plague  |
| Salmonella, 501, 512, 531         | Bacillus, 663                                     |
| General, gray rats                | Pasteurella, 549                                  |
| Leptospira, 1078                  | Pleuropneumonia-like disease, 1292                |
| Intestine                         | Thyroid infection                                 |
| Catenabacterium, 368              | Bacterium, 402                                    |
| -, white rats                     | Reptiles, Common Names                            |
| Corynebacterium, 403, 401         | Boa constrictor                                   |
| Kidneys                           | Mycobacterium, 885                                |
| Leptospira, 1077                  | Chuckawalla                                       |
| Large intestine                   | Baclerium, 161, 462                               |
| Risiella, 567                     | Gila monster                                      |
| Middle ear                        | Pseudomonas, 92                                   |
| Coccobacillary bodies of Nelson,  | Serratia, 462                                     |
| 1294                              | Horned lizards                                    |
| Not pathogenic for                | Pseudomonas, 92                                   |
| Tuberculosis, amphibian           | Serratia, 462                                     |
| Mycobacterium, 885                | Lizards   |
| Preputial glands                  | Actinomyces, 971                                  |
| Mycobacterium, 891                | Bartonella, 1108                                  |
| Red blood cells, see Erythrocytes | Mycobacterium, 833, 884, 885                      |
| Stomach                           | Pseudomonas, 92                                   |
| Spirillum, 218                    | Treponema, 1076                                   |
| Urine                             | -, gekkonid                                       |
| Leptospira, 1077                  | Serratia, 462                                     |
|                                   | -, inguanid                                       |
| Rats, Diseases of                 | Serratia, 462                                     |
| Brucellosis                       | Python  |
| Brucella, 563                     | Mycobacterium, 885                                |
| Endemic disease of                | Snakes  |
| Mycobacterium, 883                | Marchaetersvin SS6                                |
| Epizootic among white rats        | Salmonella, 503, 513, 524, 526, 527               |
| Micrococcus, 261                  | Serratia, 462                                     |
| General                           | Snakes, brown                                     |
| Actinomyces, 972                  | Serratia, 462                                     |
| Bacillus, 665                     | -, garter   |
| Clostridium, 779                  | Mycobacterium, 886                                |
| Nocardia, 922                     | Serratia, 462                                     |
| Pseudomonas, 89                   |   |

Lesions, genitoperineal region Tuberculosis, piscine Mucobacterium, 883, 884 Treponema, 1073 Tuberculosis, snake Listeriosis Mucobacterium, 886 Lasteria, 400 Red blood cells, see Erythrocytes Lung plague Stomach contents Bacternum, 552 Actinomyces, 974 Melioidosis Mattermyces, 556 Viscera Bacillus, 818 Metritia Corunebacterium, 404 Rabbits, Diseases of Necrosis of liver Abscess liver Listeria, 400 Aerobacter, 456 Necrotic Icsions Abseesses, skip Clostridium, 820 Hemophilus, 589 Pleuritis Neusseria, 301 Leptothrix, 366 Actinomycosis Pleuropericarditia Actinomyces, 928 Klebstella, 459 Anthrax Preumonia Bacellus, 603, 720 Bacillus, 647 Streptococcus, 338 Pus, stinking Blood of diseased rabbits Bacterium, 685 Clostridium, 820 Rabies-like discase Micrococcus, 272 Bacsllus, 663 Brucellasis Septicemia Brucella, 561, 562, 563 Micrococcus, 251 Conjunctival folliculosis Streptococcus, 317, 340 Nonuchia, 504 Spirochetosia Cornea, diseased Treponema, 1073 Micrococcus, 251 Suppuration Diphtheritic inflammation of intestine Leptothriz, 306 Corynebacterium, 402 Sypbilis Endometritis Leptothers, 306 Treponema, 1071, 1076 Tuberculosis, avian Epizootic Bacellus, 653 Mycobacterium, 881 Bacters um, 681 Tuberculosis, human Micrococcus, 261 Mycobacterium, 879 Erysinelas of car Tympanitis Bacellus, 655 Bacillus, 818 Glanders Tympanitis in young Malleomyces, 555, 556 Bactilus, 757 Haemobartonellosia Rats Haemokartonella, 1101 Blood Hemorrhagie septicemia Leptospira, 1077 Parteurella, 517, 519, 550, 551, 552 Spirillum, 215 Infections -, albino rate Actinomyces, 928 Corynebacterium, 403 Haemobartonella, 1104 Novardia, 911 -. desert rata

Grahamella, 1100

Streptococcus, 333

Salt and Salted Materials (continued) Chromatium, 857, 858 Salted codfish, reddened Clostridium, 820 Bacillus, 667, 742 Cytophaga, 1014, 1015 Flavobacterium, 442 Desulforibrio, 208 Micrococcus, 259 Flavobacterium, 429, 430, 431, 432, 435, Pseudomonas, 110 438, 439, 441, 631 Salted fish Leptospira, 1079 Bacillus, 658 Micrococcus, 240, 246, 254, 255, 262, - -, red spoilage 263, 267, 268, 271, 695, 696 Pseudomonas, 110 Microspíra, 202 Salted hides Photobacterium, 636, 637 Pseudomonas, 110 Pseudomonas, 107, 108, 110, 111, 112, Salted intestines (Wiener skins) 175, 697, 698, 699, 700 Tetracoccus, 284 Sarcina, 701 Salted sardines, anchovies, etc. Serratia, 484 Spirillum, 217 Vibrio, 204 Salt ponds, red Spirochaeta, 1052, 1053, 1054 Pseudomonas, 110 Streptococcus, 330 Thiobacillus, 70, 81 Salt waters, also see Sea Water Spirillum, 212 Thiopedia, 843 Thiospira, 212, 702 Solar salt Thiothrix, 990 Pseudomonas, 110 Ristella, 578 Thiovulum, 1000 Urobacterium, 691 Sarcina, 289 Vibrio, 200, 205, 703 Salt Seas and Lakes Dead Sea Sea Waters Flavobacterium, 441, 442 Ambergris Halobacterium, 234 Spirillum, 217 Pseudomonas, 147 Bottom sediments India Bacterium, 627 Flavobacterium, 631 Pseudomonas, 110 Liman, near Odessa Brine, red Pseudomonas, 110 Urobacterium, 691 Sarcina, 289 Russia Containing rotting scanceds Thiobacullus, 81 Achromatium, 999 Sand, see Soils Beggiatoa, 991, 992 Sauerkraut, see Fermenting and Fer-Thiothrix, 990 mented Materials Thiovulum, 1000 General Sea Water Pseudomonas, 175 Acetobacter, 692 Harbor at Kiel Achromobacter, 419, 421, 423, 424, 425, Spirochaela, 1053 634 Lime precipitation Bacillus, 653, 658, 660, 661, 662, 667, Preudomonas, 108 741, 743, 746, 750, 754, 818 Marine bottom deposits Bacterium, 606, 625, 626, 627, 632, 633, Bacillus, 739, 741, 748, 755, 758 635, 642, 673, 674, 675, 677, 678, 680, Micrococcus, 696 Pseudomonas, 697, 698, 699, 700, 701 681, 683, 686 Bacteroides, 566 Sarcina, 701 Beggiatoa, 991, 992, 993

Reptiles (continued)

Tortoise Bartonella, 1108

Turtle

Mycobactersum, 885, 887, 891

Mycobacto →, musk

Serratia, 462

Reptiles, Diseases of

General

Salmonella, 513, 514, 519 Serratia, 462

Lazards, contagious disease Serratia, 462

-, tumors

Bacterium, 461 Serratia, 462

Snakes, blood Spirochaeta, 1070

-, tuberculosis

Mycobacterium, 886

-, typhoid-like infection

Pseudomonas, 700 Turtles, tuberculosis

Mycobacterium, 885, 887, 891
Reptiles, Scientific Names
Anolis carolinensis, 462

Andis equestris, 462 Brasilieus cittatus, 462 Caluber catenifer, 885

Hemidaetylus brookii, 462 Lacerta sp., 971 Lacertilia sp., 1108 Python molurus, 885

Sauromalus tarius, 461 Sternothaeris odoratus, 462 Storeria dekayi, 462 Tarentola mauritanica, 462

Tasazerus cepaps, 974
Testudo graeca, 1108, 1111
Thamnophis butlers, 462

Thamnophis butleri, 462
Thamnophis sirtalis, 886
Tropidonolus stololus, 1070
Tropidurus perurianus, 1108

Retting, Flax Bacillus, 722, 814

Bacillus, 722, 814
Bacterium, 819
Clostridium, 803, 807, 821
Granulobaeter, 822, 824
Pletridium, 823, 824

Retting, Hemp

Bacterium, 681 Plectridium, 824

Retting, Kenaf (Hibiscus) Bacillus, 813, 815

Bacillus, 813, 815 Clostridium, 819 Listerella, 409 Micrococcus, 263

River Water

Bacillus, 644, 652, 654, 655, 658, 659, 667, 693, 741, 815

Bacterium, 601 Chromobacterium, 233, 234

Clostridium, 824 Flavobacterium, 433, 611

Leptothriz, 986

Micrococcus, 270, 273, 275 Pseudomonas, 93, 149, 697 Saprospira, 1055

Serratia, 484, 485 Spirochaeta, 1053, 1054

Throbacillus, 79, 81 Urebacillus, 691

Vibrio, 196, 203 Zuberella, 577

River Water, Name of River

Elbe River, 203 Granta River, Cambridge, 1053, 1054, 1055

Illinois River, 484 Mississippi River, 484, 485, 601, 644 Ohio River, 601

Rhine River, 273, 433 Schuylkill River, 93, 270, 275, 677, 693

Seine River, 824 Same River 100 651 607 000

Spree River, 196, 654, 697, 986 Znonitz River, Chemnitz, 611

Salt and Salted Materials

Chromobactersum, 231 Clostridium, 781 Pseudomonas, 109, 110

Brines Bacillus, 648, 658 Desulforibrio, 208

Pseudomonus, 109, 110, 147 Sarcina, 289

Vibrio, 702

Keratitis

Sheep (continued) Nasal secretions Streptococcus, 338 Pancreas Streptococcus, 338 Red blood cells, see Erythrocytes Stomach Streptococcus, 338 Stomach contents Bacterium, 681 Sheep, Diseases of Abortion Brucella, 561 Salmonella, 506 Agalactia Anulomyces, 1292 Anthrax Bacillus, 720 Black leg Clostridium, 773 Braxy Bacillus, 825 Circling disease Erysipelothrix, 409 Diarrhoes Bocillus, 826 Diseased lambs Bacillus, 648 Enterotoxemia Bacillus, 826 Eperythrozoónosis Eperythrozoon, 1111 Foot rot Actinomyres, 917 Spirochaeta, 1074 Treponema, 1076 Gangrenous mastitis Micrococcus, 267 Glanders Malleomyces, 555 Heartwater Consdria, 1034 Hemorrhagic septicemia Pasteurella, 549, 554 Infections Corynebacterium, 402 Rickettsia, 1095 Streptococcus, 342 Infectious mastitis

Pasteurella, 554

Colesiota, 1119 Lesions Actinomyces, 916 Listeriosis Listeria, 409 Lymphadenitis, caseous Corynebacterium, 389 Mastitis Streptococcus, 310 Necrotic areas in kidney Corynebacterium, 383 Ophthalmia, infectious Colesiota, 1120 Pleuropneumonia, bovinc Asterococcus, 1292 Pneumonia Pasteurella, 549 Purulent infections, urinary tract Corynebacterium, 389 Pyorrhoea. Leptothrix, 366 Sheep por pustules Streptococcus, 345 Struck Bacillus, 826 Tuberculosis, bovine Mucobacterium, 879 Shelifish, see Mollusca Snow Bacillus, 735 Bacterium, 760 -, melting of glacial Pseudomonas, 145 -, red Pseudomonas, 148 Soil Achromobacter, 419, 423, 421, 426, 622 Actinomyces, 968, 969, 970, 971, 972, 973, 974 Aerobacter, 456 Agrobacterium, 230 Alcaligenes, 416 Angiococcus, 1048 Archangium, 1019 Azolobacter, 220, 221 Azotomonas, 222 Bacillus, 622, 623, 631, 619, 650, 653, 656, 660, 662, 663, 664, 665, 666, 665,

Sea Waters (continued) Natrosogloca, 73, 74 Marine hottom deposits (continued) Pseudomonas, 89, 90, 91 Thiospira, 702 Salmonella, 529 Vibrio, 703 Sarcina, 287 Marine mud, see Mud, Marine Spirillum, 203 Marine phytoplankton Thiobacillus. 79 Urobacslius, 691 Bacillus, 743 Vibrio, 703 Vibrio, 203, 204 Mussel beds Drains of slaughter houses Desulfavibrio, 207 Bacellus, 825 Submerred surfaces Filterable bodies, 1294 Bactersum, 606, 607 Sewage Deposits Flavobacterium, 631 Slime Micrococcus, 696 Achromobacter, 423 Pseudomonas, 697, 699, 700 Bacterium, 610, 615 Sulfur waters Sludge, activated Beggiatoa, 991, 992, 993 Natrocustis, 75 Thropedia, 813 Nitrosocyatis, 73 Thiothrix, 900 Nilrosogloca, 73, 74 Tropical waters Nitrosospira, 71 Pseudomonas, 108 Pseudomonas, 81, 150 Sea Waters, Geographical Distribution Vibrio, 702 Arctic Ocean, 202, 254, 255 Sludge, fermenting Australia, Elizabeth's Bay, 634 Screina, 287 Baltic Sea, 636 Sewage Effluents Barents Sea, 423 Achromobacter, 419, 426 California Coast, 419, 421, 430, 431. Chromobacterium, 233 432, 606, 607 Natrocystia, 75 Denmark, Coast of, 217 Sewage Plants Kiel, Harbor at, 483, 1053 Naples, Gulf of, 425, 745, 748 Filter beds Micrococcua, 269 North Pacific Coast, 175 Norwegian Coast, 200, 626 Pseudomonas, 91 Settling basin Pacific Coast, U. S A. 107 Scotland, Coast of, 741 Clonothrix, 983 West Indics, 112 Sheep Woods Hole, Massachusetts, 111, 660, Blood 661,750 Rickettsia, 1097 Sewage Spirochaeta, 1068 Achromobacter, 420, 427 Bronchi Bacillus, 654, 667, 670, 729, 730, 735, Hemophilus, 589 813, 811, 816, 817, 833 Corneal or conjunctival discharges Bacterium, 610, 675, 685, 687, 688 Colesista, 1120 Clastridium, 783, 701,812 Erythrocytes Desulforibrio, 208 Eperythrozoon, 1112 Escherichia, 452 Methanobacterium, 646 Salmonella, 502, 509, 528 Microspira, 202, 203 Intestine Nitrobacter, 75 Bacillus, 815

Bacterium, 630

Nitrocystus, 75

Green fluorescent pigment produced in culture (Burkholder).

Gelatin: Not liquefied

Glucose agar slants: Growth moderate, filiform at first, later beaded, raised, smooth, white. Butyrous in consistency.

Milk: Becomes alkaline. No other

change.

Nitrites not produced from nitrates.
Indole not produced.

No H<sub>2</sub>S produced.

Not lipolytic (Starr and Burkholder,

Phytopath., \$2, 1942, 601).

Acid from glueose, galactose, and sucrose. Maltose and rhamnose not

utilized (Burkholder).

No gas from carbohydrates

Starch not hydrolyzed.

Optimum temperature 18°C. Maximum 30°C. Minimum 7°C.

Aerobic.

Sources: Repeated isolations from leaves and twigs of barberry.

Habitat: Pathogenic on barberry, Berberis thunbergeris and B. vulgaris.

75. Pseudomonas coronafaciens (Elliott) Stapp. (Baclerium coronafaciens Elliott, Jour. Agr Res. 19, 1920, 153; Phytomonas coronafaciens Bergey et al., Manual, 1st ed., 1923, 180, Stapp, in Sorauer, Handbuch der Pflanzenkrankheiten, 2, 5 Auf., 1928, 20) From L. corona, halo; faciens, producing, referring to the lessons on act blades.

Probable synonyms Elliott (Bact. Plant Pathogens, 1930, 122) lists as synonyms, Bacillus arenae (Russell, Johns Hopkins Univ. Thesis, 1892) and Bacillus arenae Manna arenae Manna (Ohio Agr. Exp. Sta. Bul. 210, 1909, 133; Phytomonas arenae Bergey et al., Manual, 3rd ed., 1930, 263).

Rods: 0 65 by 2.3 microns, occurring in chains Motile with polar flagella Capsules. Gram-negative.

Green fluorescent pigment produced in culture.

Gelatin Slow liquefaction.

Nutrient agar colonies White, becom-

ing irregularly circular, flat with raised margins.

Broth: Slight turbidity in 24 hours. Heavy pelliele formed.

Milk: Alkaline. A soft curd formed followed by clearing. Curd sometimes absent.

Nitrites not produced from nitrates.

Indole not formed.

No II:S formed.

Not lipolytic (Starr and Burkholder, Phytopath., 32, 1942, 601).

Acid but no gas from glucose and suerose. Starch hydrolysis slight.

Slight growth in broth plus 2 per cent salt.

Optimum temperature 24° to 25°C. Maximum 31°C. Minimum 1°C.

Source: Numerous isolations from blighted blades of oats.

Habitat: Causes a halo spot on oats (Arena satira). Artificial inoculations show barley (Hordeum vulgare), rye (Secale cereale) and wheat (Triticum aestirum) to be susceptible.

75a. Pseudomonas coronafaciens var. atropurpurea (Reddy and Godkin) Stapp. (Bacterium coronafaciens var. atropurpureum Reddy and Godkin, Phytopath., 13, 1923, 81; Stapp, in Sorauer, Handbuch der Pflantenkrankheiten, 2, 5 Auf., 1923, 9, Phytomonas coronafaciens var. atropurpurea Magrou, in Hauduroy et al., Diet. d. Baet Path., Paris, 1937, 371.) From L eter, black, dark; purpureus, purple, referring to the color of the lesion on home erass.

Distinctive characters: This variety differs from Pseudomonas coronafaciens in that it infects the brome-grass, Bromus inermis, where it produces a water soaked spot which is dark purple in color.

Source: Numerous isolations from diseased brome-grass.

Habitat: Pathogenic on Bromus inermis and Agropyron repens. Has been artificially inoculated on loats, Arena satura.

Mucococcus, 891

```
Micromonespora, 979, 980
Soil (continued)
                                                Mucobacterium, 885, 887, 888, 890, 919
  Bacillus (continued)
    669, 670, 671, 672, 711, 712, 713, 714,
                                                Mucoplana, 191
    715, 717, 719, 721, 722, 723, 724, 725,
    726, 728, 729, 730, 731, 732, 733, 734,
                                                Myzococcus, 1042, 1043, 1044
    735, 736, 737, 738, 739, 740, 741, 742,
     743, 744, 745, 746, 747, 749, 750, 751,
    752, 753, 754, 755, 756, 757, 758, 813,
    814, 815, 816, 817, 818, 824, 825, 826,
     827
   Bactersum, 76, 407, 408, 602, 603, 613,
     614, 615, 637, 638, 642, 643, 673, 674,
     676, 677, 679, 682, 685, 688, 760, 761,
     762
   Bactoderma, 76
   Butylobacter, 825
   Cellfalcicula, 211
   Cellulomonas, 617, 618, 619, 620, 621,
     622
   Cellvibrio, 210, 211
   Chondrococcus, 1045, 1046
   Chondromyces, 1037, 1038, 1039
   Chromobacterium, 233
   Cladothrix, 083
   Clostridium, 770, 772, 773, 774, 776,
     778, 770, 781, 782, 783, 784, 785, 788,
     789, 791, 793, 794, 795, 797, 798, 799,
     800, 801, 802, 809, 810, 811, 812, 819,
     820, 821, 824, 825
    Cornilia, 822
    Corynebacterium, 391, 393, 394, 396,
      397, 398, 403, 401, 407, 408
    Cutophaga, 1013, 1014
    Denstrobacterium, 690, 762
    Desulforibrio, 208
    Escherichia, 419, 450, 452
    Flavobacterium, 429, 430, 436, 438, 440
```

Granulobacellus, 821, 826

llydrogenomonas, 77, 78

Hyphomicrobium, 837

Granulobacter, 822, 821

Hiblerillus, 822

Lactobacillus, 361

Melittangium, 1034 Methanobacterium, 616

Methanococeus, 219

Methanomenas, 179

275, 281, 696

Microlermo, 76

Microbacterium, 370, 371

Micrococcia, 238, 251, 255, 270, 271,

Nitrobacter, 74, 75, 76 Nitrosobacillus, 690, 762 Nitrosococcus, 71 Nitrosocustis, 72, 73 Nitrosomonas, 70, 71, 76 Nitrosospira, 72 Natrospira, 72 Nocardia, 897, 898, 899, 902, 903, 904, 905, 906, 908, 913, 914 Paracolobactrum, 460 Pectinobacter, 823 Plectridium, 823 Podangium, 1035 Polyangum, 1027, 1028, 1029, 1030, 1031, 1032 Proactinomyces, 923 Propionibactersum, 376 Protaminobacter, 190 Pseudomonas, 90, 92, 94, 95, 97, 98, 99, 100, 104, 105, 106, 145, 147, 149, 150, 174, 176, 177, 179, 608, 700 Rhodococcus, 275 Saccharobacterium, 623, 624 Sarcina, 286, 287, 288, 293, 294 Serratio, 481 Sorangum, 1022, 1023, 1024 Spirillum, 215, 216 Sporocutophaga, 1048, 1050 Streptobacillus, 823 Streptococcus, 337, 341, 344 Streptomyces, 935, 936, 937, 938, 939, 910, 911, 912, 913, 914, 015, 916, 917, 948, 950, 951, 952, 953, 954, 955, 956, 957, 958 Thiobacillus, 79, 80, 81 Thiospira, 212 Urchacillus, 691 Vibrio, 199, 200, 201, 203, 204, 205, 206, Sails

Acid humus soils

Adobe soil

Streptomyces, 956

Actinomyces, 968

Streptomyces, 937, 943, 945, 952, 954,

| Solls (continued)                       | Made soils                            |
|---|---------------------------------------|
| Black, see Mud                          | Cladothrix, 983                       |
| Polyangium, 1023, 1029                  | Manured soils                         |
| Compost of soil, sulfur and rock phos-  |                                       |
| phate                                   | Clostridium, 776, 778, 783, 822       |
| Thiobacillus, 79                        | Nitrogloca, 73                        |
| Containing incompletely oxidized sul-   | Marine mud, see Mud, marine           |
| fur compounds                           | Mud, see Mud                          |
| Thiobacillus, 79                        | Oil-scaked soil, see Mineral Sources  |
| Containing urine                        | Orchard                               |
| Micrococcus, 238                        | Streptomyces, 914, 931                |
|   | Pasture land                          |
| Descrit                                 | Hydrogenomonas, 78                    |
| Actinamyces, 972, 973                   | Pent, see Pent                        |
| Field                                   | Peat soils                            |
| Azotobacter, 220                        | Actinomyces, 969, 974                 |
| Bacillus, 732                           | Podzol (Russian)                      |
| Nitrosospira, 71                        | Polyangium, 1029                      |
| Filterable bodies, 1234                 | Potato fields                         |
| Forest                                  | Actinomyces, 971                      |
| Bacillus, 666, 752                      | Roadside                              |
| Cellfalcicula, 211                      | Bacillus, 671                         |
| Cellesbrio, 210                         | Sand                                  |
| Nitrasegloca, 73                        | Bacillus, 658                         |
| Garden                                  | Bacterium, £85                        |
| Actinemyces, 969, 970                   | Sarcina, 288                          |
| Bacellus, 664, 660, 669, 672, 739, 743, | -, beach                              |
| 745, 750, 752, 754, 755, 815, 826       | Pseudomonas, 697, 698, 700            |
| Bacterium, 673, 685                     | Vibrio, 702, 703                      |
| Clostridium, 781, 793, 798, 799, 811,   | -, faraminiferous                     |
| 820, 825, 826                           | Saprospira, 1051, 1055                |
| Cornilia, 822                           | , sca                                 |
| Granulobacter, 822                      | Acetobacter, 602                      |
| Hydrogenomonas, 78                      | Bacterium, 627, 632                   |
| Lactobactersum, 364                     | Sandy loam                            |
| Methanococcus, 248                      | Steeptomyces, 938                     |
| Micrococcus, 270                        | Shore soils                           |
| Mycobacterium, 890                      | Chitin digesting bacteris, 632        |
| Pseudomonas, 698                        |                                       |
| Sarcina, 286, 291                       | Sour soils                            |
| Spirillum, 216                          | Actinomyces, 971, 973                 |
| Streptobacillus, 823                    | Subsoil                               |
| Streptomyces, 936, 939, 948             | Streptomyces, 953                     |
| Urobacillus, 691                        | Swamp                                 |
|   | Bacillus, 662, 750                    |
| Vibrio, 203                             | Flavobacterium, 438                   |
| Greenhouse                              | Uncultivated                          |
| Nitrocystis, 75                         | Saccharobacterium, 623, 624           |
| Humus<br>Gladeidium 770                 | ** * 1 - 11-                          |
| Clostridium, 770                        | Streptomyces, 936, 945, 948, 951, 952 |
| Urobacillus, 691                        | Veretable moid                        |
| Legume<br>Bhi-chium, 225, 226, 227, 230 | Hydrogenomonas, 78                    |

Soils (continued) Virgin Cladothrix, 983 Volcanic (Martinique) Actinomyces, 969 Walls, cellar and mine, see Mineral Sources Soils, Geographic Distribution of Antartic, 72 Argentina, 807 Australia, 71, 897, 902, 903, 905, 906, 913 Australia, garden soil, 397 Australia, grass land, 393, 391, 397, 403 Australia, red soil, 207, 208 Austria, 77, 738 Brazil, 71 California, 176, 397, 614, 615, 619, 620, 621, 743, 746, 761, 936, 938, 943, 945, 948, 951, 952, 954 Connecticut, 622, 623 Cuba, 737, 738, 739, 741, 748, 753, 757 Denmark, 947 District of Columbia, 622, 749 Ecuador, 71 Egypt, 713, 737, 744, 757 England, 97, 741, 742 Europe, 713, 750 Florida, 762 France, 70, 71, 72, 73, 897 Georgia, 623 Germany, 210, 211, 503, 732, 736, 737, 738, 739, 742, 745, 747, 748, 749, 752, 753, 755, 750, 757, 758 Great Britain, 898, 899, 903, 904, 906, 913 Hawan, 938 Holland, 746, 905 India, 221 Italy, 70, 608, 739, 753, 757, 758, 803, Jipan, 72 Java, 73 Jugoslavia, 742 Kentucky, 623 Louisiana, 174, 617, 618, 619 Maine, 617, 623 Martimque, 202 Maryland, 737 Missouri, 174

Montenegro, 744

New Hampshire, 619 New Jersey, 642, 945 New York, 622, 623, 750 North Carolins, 742, 762 Palestine, 757 Poland, 1018, 1019, 1023, 1027, 1030, 1031, 1034, 1035, 1037, 1042, 1043 1044, 1045 Russia, 70, 658, 1028, 1029, 1030 Sahara Desert, 337, 341, 819, 820, 821 South Carolina, 622, 623 Switzerland, 70 Tunisia, 72 United States, 210, 211, 807 Utab, 92, 615, 617, 618, 741 Virginia, 174, 179, 614 Wisconsin, 619 Spring Waters At Spalato Chromobacterium, 233 At Vranje Bacillus, 732 Containing from Bacillus, 732 Gallionella, 831, 832 Naumanniella, 834 Hot aprings Bacillus, 760 Bacterium, 681 Chlamydothriz, 986 Micrococcus, 262, 279 Spirochaeta, 1053 Streptococcus, 311 Thiobacellus, 81 Thiosphaerion, 859 Hot sulfur springs Bacillus, 656 Mecrobacillus, 690 Micrococcus, 253 Sulfur springs Amochobacter, 849, 850 Bacillus, 732 Chlorobium, 870 Clathrochloris, 872 Lamprocystia, SIS Leptothriz, 995 Pelodictyon, 871, 872

Rhabdomonas, 854, 855

Rhodothece, 856

Thiocapsa, 813

| Spring Waters (continued)             |
|---------------------------------------|
| Sulfur springs (continued)            |
| Thiocystis, 847                       |
| Thiodictyon, 848                      |
| Thiopedia, 843                        |
| Thiopolycoccus, 850                   |
| Thiosarcina, 843                      |
|                                       |
| Thiospirillum, 851, 852               |
| Thiothece, 846<br>Thiothrix, 989, 990 |
|                                       |
| Warm springs                          |
| Bacillus, 756                         |
| Sugar                                 |
| Candy                                 |
| Bacillus, 756                         |
| Factory                               |
| Bacillus, 744                         |
| Micrococcus, 260                      |
| Molasses                              |
| Clostridium, 781                      |
| Lactobacillus, 359                    |
| Refineries                            |
| Lampropedia, 844                      |
| Leuconostoc, 347, 348                 |
| Nevskia, 830                          |
| Refining vats, seum                   |
| Clostridium, 808                      |
| Solutions                             |
| Clostridium, 824                      |
| Sugar (sucrose) solutions, slimy      |
| Bacillus, 742, 745, 747               |
| Clostridium, 762                      |
| Leuconostoc, 347, 348                 |
| Myxobacillus, 762                     |
| Streptobacterium, 702                 |
| Syrup                                 |
| Nevakia, 830                          |
| Wastes                                |
| Clostridium, 762                      |
| Swamps                                |
| Aerobacter, 592                       |
| Bacterium, 676, 685, 686              |
| Saccharobacterium, 623, 524           |
| Swamp Soils, see Soils, Swamp         |
| Swamp Sons, acc Sons, Swamp           |
| Swamp Waters, see Waters, Swamp       |

Swine, see Hogs

Tannery Wastes

Bacterium, 677

Acid dyeing liquor

Rotterdam, 202

Tap Water Bacillus, 484, 647, 648, 649, 650, 651, 632, 656, 657, 666, 668, 669, 671, 672, 723, 738, 740, 742, 744, 747, 748, 719, 751, 752, 754, 756, 758 Bactersum, 457, 605, 513 Hyphomicrobium, 837 Leptospira, 1077 Micrococcus, 255, 256, 257, 258, 262, 274, 276, 277 Protaminobacter, 190 Pseudomonas, 102, 698 Sarcina, 290, 291 Serratia, 481 Terminosporus, 823 Vibrio, 203 Tap Water, Place Obtained

Berlin, 1077 Chemnitz, 102, 256, 257, 258, 262, 274, 277, 290, 291, 481, 648, 649, 650, 651, 652, 656, 657, 666, 668, 669, 671, 672, 740, 742, 747, 748, 749, 751, 752, 754, 758 Kiel. 698 Lawrence, Mass., 723 Leitmeritz, 255, 256, 262, 276, 277, 457, 647, 657, 738, 740, 711, 752, 751 Ohio, 756 Minneapolis, 823 Plymouth, England, 481 Rome, 613

Urine Micrococcus, 238, 247, 260, 266, 267, 269, 279, 280 Pediococcus, 250

Vegetable Sources, see Plant Sources

Viruses, Animal Hosts of Agouti, 1265 Angs boscas, 1253 Anas platyrhyncha, 1251, 1253 Anatidae, 1251, 1253 Anser anser, 1251, 1253 Anger einereus, 1253 Autelope, 1276 Apidae, 1227 Apes mellifera, 1227 Apodemus sylvatious, 1267

Viruses, Animal Hosts of (continued) Cercomthecus callitrichus, 1267 Artibeus planirostris, 1263 Asyndesmus lewis, 1252 Bat. fruit-eating, 1263 Bat, vampire, 1263 Bee, honey, 1227 Birds, 1249 Bison, 1239 Blackbird, 1253 Bob-white, 1253 Bombycidae, 1226 Bombyz mors, 1226, 1227 Bos taurus, 1239, 1241, 1242, 1251, 1253, 1267, 1272, 1276, 1278 Bovidae, 1238, 1239, 1241, 1242, 1248, 1251, 1253, 1267, 1272, 1276, 1278 Bubo rirginianus, 1252, 1253 Buffalo, 1276 Bunting, 1229 Bushbuck, 1276 Buteo vulgaris, 1263 Cabbage worm, 1227 Calf, 1253 Camel, 1276 Canary, 1229, 1279, 1280 Canidae, 1211, 1242, 1251, 1253, 1263, 1272, 1273, 1277 Canis familiaris, 1241, 1242, 1251, 1253, 1263, 1272, 1277 Capra hircus, 1251, 1253, 1267 Caracal lyny, 1271 Cat. 1235, 1236, 1255, 1262, 1263, 1271, 1279, 1284 Cat, black-footed, 1263 Cat, marbled, 1271 Cat, wild, 1263 Cattle, also see Cow, 1231, 1236, 1239, 1240, 1242, 1249, 1263, 1272, 1276, 1278 1277 Carra porcellus, 1237, 1277, 1285 Cavildae, 1237, 1277, 1285 Cebidae, 1235 Cebus chrusopus, 1267 Cebus fatuellus, 1267 1279 Cebus Quraceus, 1235 Cercocebus fuliginosus, 1235, 1267 Cereocebus torquatus, 1265 Cercopithecidae, 1231, 1235, 1237, 1259, Cercopithecus aethiops, 1257, 1265, 1266

Cerconithecus tantalus, 1265 Charadriidae, 1253 Chicken, 1229, 1231, 1236, 1242, 1252, 1253, 1262, 1263, 1265, 1274, 1279, 1280, 1283 Chicken embryo, 1229, 1231, 1234, 1235, 1236, 1238, 1239, 1240, 1245, 1248, 1252, 1253, 1259, 1260, 1263, 1267, 1268, 1270, 1271, 1274, 1277, 1279, 1280 Chimpanzee, 1271 Chrysemys marginata, 1231 Ciconia ciconia, 1253, 1263 Circus rufus, 1253 Citellus richardsonii, 1253 Colaptes cafer, 1252, 1253 Columba livia, 1251, 1253 Columbidae, 1251, 1253 Cotton rat, 1253, 1257 Cow, also see Cattle, 1231, 1239, 1241, 1248, 1250, 1251, 1253, 1256, 1267 Cowbird, 1253 Covote, 1273 Cricetidae, 1253, 1285 Cricetulus furunculus, 1249 Cricetulus griseus, 1285 Cricetus auratus, 1267 Cynalopez chama, 1263 Cyniciis penicillata, 1263 Dasyprocta aguti, 1265 Deer, 1256, 1276 Desmodus rufus, 1263 Diardigallus diardi, 1263 Dipodomys heermanns, 1253 Dog, 1235, 1236, 1241, 1242, 1251. 1253, 1255, 1259, 1263, 1272, 1273, Donkey, 1277, 1282 Dormouse, 1267 Dove, western mourning, 1251 Duck, 1229, 1236, 1212, 1251, 1253, Duck embryo, 1215, 1253 Duck, mallard, 1251, 1253 Duck, Fekin, 1251, 1253 Duiker, 1276 Eland, 1276 Equidae, 1251, 1253, 1277, 1278, 1282 Equus asinus, 1277, 1282

Viruses, Animal Hosts of (continued) Rat, 1238, 1239, 1248, 1256, 1267, 1268, 1277, 1279, 1286 Rat, black, 1253 Rat, brown, 1236, 1251 Rat, white, 1236, 1253, 1257, 1259, 1262, 1277 Rattus norvegicus, 1238, 1251, 1277 Rattus rattus, 1253 Reindeer, 1239 Reithrodontomys megalatus, 1253 Robin, 1252, 1253 Robin embryo, 1253 Sciuridae, 1263 Sciurotamius davidianus, 1268 Sciurus carolinensis, 1267 Sciurus vulgaris, 1265 Sheep, 1232, 1234, 1236, 1238, 1239, 1248, 1249, 1250, 1251, 1253, 1255, 1256, 1263, 1267, 1276, 1278 Sigmodon hispidus, 1253, 1257 Silkworm, 1226, 1227 Sparrow embryo, 1253 Sparrow, English, 1229, 1253 Sparrow, Gambel's, 1253 Spectyto cunicularia, 1253 Squirrel, David's, 1268 Squirrel, gray, 1267 Squirrel, red, 1265 Stork, 1263 Stork, white, 1253 Strigidae, 1252, 1253 Suldae, 1252, 1253, 1262, 1268, 1275, Suricata suricata, 1263 Suricate, Cape, 1263 Sus scrofa, 1233, 1252, 1253, 1262, 1268, 1275, 1282 Swine, also see Pig, 1232, 1233, 1234, \* 1236, 1240, 1262, 1268, 1275, 1276, 1282 Sylvilagus audubonii, 1253 Sylvilagus bachmani, 1253

Sylvilagus nuttallı, 1251

Tatera lobengula, 1277 Tetraonidae, 1253

Tiger cat, African, 1271

Thrasher, 1253

Tiger, 1271

Sylvilagus sp , 1244, 1245, 1247

Turdus migratorius, 1252, 1253 Turkey, 1229, 1251, 1253, 1279 Turkey embryo, 1253, 1274 Turtle, 1231 Tympanuchus cupido, 1253 Vivreridae, 1263 Vole, field, 1253, 1265, 1267 Vulpes sp., 1272, 1273 Vultur fulvus, 1253 Vulture, tawny, 1253 Warthog, 1275 Weasel, 1253 Wolf, 1263 Woodchuck, 1253 Woodpecker, Lewis, 1252 Wood rat, 1253 Zebra, 1277 Zebu cattle, 1276 Zenaidura macroura, 1251 Zonotrichia leucophrys, 1253 Viruses, Bacterial Rosts of Agrobacterium tumefaciens, 1134 Bacillus megatherium, 1138 Bacillus mycordes, 1138 Bacterium stewarti, 1136 Corynebacterium diphtheriae, 1143, 1144 Erwinia aroideae, 1136 Erwinia carotovora, 1135 Escherichia coli, 1131, 1132, 1133, 1134 Pseudomonas solanacearum, 1135 Rhizobium leguminosarum, 1138 Salmonella enteritidis, 1136, 1137 Salmonella gallinarum, 1136, 1137 Salmonella typhosa, 1137 Shigella dysenteriae, 1131, 1132, 1133, 1134, 1136, 1137 Staphylococcus albus, 1140, 1141, 1142 Staphylococcus aurcus, 1140, 1141 Staphylococcus muscae, 1142 Streptococcus cremoris, 1138, 1139 Streptococcus mucosus, 1139 Streptococcus sp., 1139, 1140 Vibrio comma, 1142, 1143

Tiger cat, American, 1271

Tiger cat, rusty, 1271

Turdus merula, 1253

Toxostoma lecontei, 1253

Viruses, Bacterial Hosts of (continued) Xanthomonas citri, 1135 Xanthomonas pruni, 1135

Viruses, Plant Hosts of

Abacá, 1193 Abutilon sp , 1186

Aperatum convigues, 1218

Agropuron repens, 1162, 1202 Alfalfa, 1151, 1153, 1181, 1191

Allium cepa, 1184

Almond, 1152, 1196 Alopecurus fulvus, 1160

Althaea ficifolia, 1186 Althaea officinalis, 1186

Althaea rosea, 1186, 1218

Amaranthaceae, 1204, 1214 Amaranthus retroflexus, 1204, 1214

Amygdalus persica, 1197

Ananas comosus, 1223

Anemone nemorosa, 1158 Anemone ranunculoides, 1158

Anemone trifolia, 1158

Anethum graveolens, 1176 Anoda hastata, 1186

Anthriscus cerefolium, 1176

Antirrhinum majus, 1191

Aprum graveolens, 1147, 1176, 1199, 1200

Apocynaceae, 1149, 1150, 1152

Apple, 1194

Apricot, 1152, 1196 Arachis hypogaea, 1187

Armoracia rusticana, 1177 Asclepiadaceae, 1173

Asclepias syriaca, 1173

Aster, 1168 Atriplex hortensis, 1204

Atriplex sibiríca, 1204 Atropa belladonna, 1175

Atena byzantina, 1161 Arena fatua, 1161

Arena satira, 1160, 1161, 1162, 1192 Barbarca vulgaris, 1155

Barley, 1161, 1162, 1192 Bean, 1168, 1169, 1179, 1180, 1181,

1189, 1190, 1191, 1216, 1219

Bean tree, 1187 Beet, 1178, 1221

Berteroa incana, 1177

Beta cicla, 1204 Beta maritima, 1201

Beta vulgaris, 1149, 1177, 1178, 1199, 1204, 1216, 1219, 1221

Bittersweet, 1175, 1204, 1214

Black-eved Susan, 1155 Brachiana platuphulla, 1183

Brassica adpressa, 1176, 1200

Brassica alba, 1176, 1177, 1200 Brassica arvensis, 1176, 1177, 1200

Brassica campestris, 1176

Brassica chinensis, 1177 Brassica incana, 1199

Brassica juneca, 1176, 1177, 1200

Brassica napobrassica, 1177, 1221 Brassica napus, 1176, 1177, 1221

Brassica nigra, 1176, 1177, 1200

Brassica oleracea, 1176, 1177, 1200 Brassica pe-tsat, 1176, 1200

Brassica rapa, 1176, 1177, 1200

Broad bean, 1179, 1180, 1187 Broccoli, 1176

Brome-grass, awnless, 1192

Bromeliaceae, 1228 Bramus inermis, 1162, 1192

Brussels sprouts, 1176

Buckwheat, 1146, 1190 Cabbage, 1176, 1177

Calendula, 1150

Calendula officinalis, 1150, 1177 Callistephus chinensis, 1146

Candytuft, rocket, 1176

Cantaloupe, 1199, 1200 Capsella bursa-pastoris, 1176, 1177.

Capsicum frulescens, 1164, 1171, 1175.

1181, 1214 Caraway, 1176

Cardamine heterophylla, 1177

Carrot, 1146, 1176 Carum carri, 1176

Caryophyllaceae, 1191 Cauliflower, 1176

Celastraceae, 1187

Celeriac, 1176

Celery, 1147, 1173, 1174, 1176, 1199. 1200 " Chaetochloa lutescens, 1183

Chaetochloa magna, 1183 Chaetochloa rerticillata, 1183

Charlock, 1176

Charlock, white, 1176

Viruses, Plant Hosts of (continued) Cheiranthus allionii, 1177 Cheiranthus cheiri, 1177 Chenopodiaceae, 1149, 1177, 1178, 1191, 1199, 1200, 1204, 1216, 1219, Chenopodium album, 1199, 1200, 1204 Chenopodium murale, 1199, 1200, 1220 Cherry, 1152, 1196, 1197, 1198 Cherry, flowering, 1197, 1210 Cherry, Mahaleh, 1197 Cherry, Mazzard, 1197, 1210 Cherry, sand, 1152 Cherry, wild, 1197 Chinese cabbage, 1177 Chokecherry, 1152 Chrysanthemum leucanthemum, 1155 Chrysanthemum morifolium, 1214 Cicer arietinum, 1180 Citrullus vulgaris, 1167 Citrus aurantium, 1202 Citrus limonia, 1210 Citrus maxima, 1210 Citrus einensis, 1210 Clover, alsike, 1180, 1187, 1190 Clover, cluster, 1180, 1190 Clover, crimson, 1156, 1157, 1180, 1181, 1187 Clover, nodding, 1190 Clover, Persian, 1180 Clover, red, 1155, 1179, 1187, 1190 Clover, spotted bur, 1180 Clover, strawberry, 1190 Clover, toothed bur, 1180 Clover, white, 1188, 1189, 1190, 1191 Commelina sp , 1174 Compositae, 1147, 1150, 1155, 1168, 1169, 1174, 1177, 1178, 1179, 1181, 1212, 1214, 1218, 1223 Convolvulaceae, 1149, 1198 Coriander, 1176 Coriandrum sativum, 1176 Corn, 1158, 1159, 1160, 1161, 1162, 1183 Coronopus didymus, 1177 Cotoneaster harroviana, 1194 Cotton, 1218 Cowpea, 1169, 1173, 1174, 1188, 1189 Cranberry, 1150 Cress, common winter, 1155

Crees, garden, 1176 Crotalaria retusa, 1190 Crotalaria spectabilis, 1190 Crotalaria striata, 1190 Cruciferae, 1155, 1176, 1177, 1197, 1200 1221 Cucumber, 1167, 1168, 1173, 1181, 1190, 1200, 1216 Cucumber, wild, 1173 Cucumis anguria, 1167 Cucumis melo, 1167, 1173, 1190, 1199, 1200 Cucumiz satious, 1167, 1173, 1181, 1190, 1191, 1200, 1212, 1216 Cucurbitaceae, 1167, 1181, 1190, 1191, 1199, 1200, 1212, 1216, 1219 Cucurbita pepo, 1173, 1190, 1200 Curcurbita ep., 1219 Cuscuta californica, 1198 Cuscuta compestris, 1199 Cuscuta subinclusa, 1199 Cytisus hirsulus, 1187 Dablia, 1179 Dahlia imperialis, 1179 Dahlia mazonii, 1179 Dahlia pinnata, 1179 Datura stramonium, 1147, 1169, 1171, 1174, 1175, 1200, 1201, 1214, 1216 Daucus carola, 1176 Delphinium sp., 1177, 1290, 1216 Desmodium canadense, 1180 Digitaria horizontalis, 1159 . Dodder, also see Dodder as vector, 1193 Dodonaca viscosa, 1149 Echinochloa crusgalli, 1160, 1162 1183 Echinocystis Iobata, 1173 Eggplant, 1147 Eleusine indica, 1159 Elm, American, 1154 Endive, 1146 Ericaceae, 1150 Briobotrya zaponica, 1194 Eulalia, 1183 Euonymus japonica, 1187 Euonymus radicans, 1187 Euphorbiaceae, 1219

Fagopyrum esculentum, 1199

Ficus sp., 1201, 1202

Viruses, Plant Hosts of (continued) Fragaria species and hybrids, 1195, 1207, 1208 Galega officinalis, 1190 Galtonia candicans, 1184 Geraniaceae, 1168, 1199 Geranium, 1199 Gherkin, 1167 Glycine soja, also see Soja max, 1190 Goat's rue, 1190 Gossyprum hirsutum, 1216, 1218 Gossupium perurianum, 1218 Gossypsum vitifolium, 1218 Gramineae, 1157, 1158, 1159, 1160, 1161, 1162, 1183, 1192, 1208 Grape, 1153, 1198 Granefruit, 1210 Grass pea, 1180 Goundsel, 1178 Henbane, 1171, 1175, 1214 Hesperis matronalis, 1177 Hibiscus sp., 1218 Holeus sorghum, 1183 Holeus audanensia, 1183 Hollybock, 1218 Holodiscus discolor, 1207 Honesty, 1176 Hop, European, 1151 Hordeum vulgare, 1161, 1162, 1192 Horse-radish, 1177 Humulus lupulus, 1151 Hyacinth, 1184 Hyacinthus orientolis, 1184 Hyoscyamus niger, 1171, 1175, 1214 Iberis amara, 1176 Indian tobacco, 1151 Iridaceae, 1183 Iris, 1183 Iris, bearded, 1183 Iris, bulbous, 1183 Ins filifolia, 1183 Iris ricardi, 1183 Iris lingitana, 1183 Iris unguicularis, 1183 Iris ziphium, 1183 Jimson weed, 1171, 1174, 1175, 1200, 1201, 1214 Kale, 1176 Kıtaibelia rıtifolia, 1186

Knotweed, 1199

Labiatae, 1173 Laburnum anagyroides, 1187 Laburnum pulgare, 1187 Lachenalia sp., 1184 Lactuca sativa, 1178, 1223 Lamb's quarters, 1199, 1204 Larkspur, 1200 Lathgrus odoratus, 1178, 1179, 1180, 1187, 1189, 1190, 1191 Lathurus salivus, 1180 Lavatera arborea, 1186 Leguminosae, 1150, 1151, 1153, 1155. 1156, 1157, 1168, 1169, 1178, 1179, 1180, 1181, 1187, 1188, 1189, 1190, 1191, 1212, 1216, 1219, 1223 Lemon, 1210 Lens esculenta, 1189, 1191 Lepidrum ruderale, 1177 Lepidium sativum, 1176, 1177 Lepidium virginicum, 1177 Lespedeza striata, 1179 Lettuce, 1146, 1178, 1223 Ligustrum vulgare, 1187 Liliaceae, 1182, 1184, 1211 Lilium amabile, 1182 Lalium auratum, 1182 Lilium canodense, 1182 Lilium candidum, 1182 Lalium cernuum, 1182 Lilium cholcedonicum, 1182 Lilium croccum, 1182 Lilium darmottiae, 1182 Leleum elegans, 1182 Lilium formosanum, 1182 Lilium giganteum, 1182 Lilium henrys, 1182 Lalium leucanthum, 1183 Lilium longiflorum, 1182, 1211 Litium myrrophyllum, 1182 Lilium pumilum, 1182 Lilium regale, 1182 Lilium sargentiae, 1182 Lileum speciosum, 1182 Lilium superbum, 1182 Lilium testaceum, 1182 Libum tigrinum, 1152 Lilium umbellatum, 1182 Lilium wallarei, 1192 Lily, 1174 Lily, Easter, 1211

Viruses, Plant Hosts of (continued) Lims bean, 1174, 1188 Locust, black, 1150 Loganberry, 1206 Loquat, 1194 Lotus hispidus, 1190 Lucerne, 1151, 1153, 1181, 1191 Lunaria annua, 1176 Lupine, blue, 1180, 1190 Lupine, white, 1180 Lupine, yellow, 1190 Lupinus albus, 1180, 1189, 1190, 1191 Lupinus angustifolius, 1180, 1190 Lupinus densiflorus, 1180 Lupinus hartwegti, 1180 Lupinus hirentus, 1191 Lupinus luteus, 1190 Lupinus mutabilis, 1190 Lupinus nanus, 1180 Lycium barbarum, 1172 Lycopersicon esculentum, 1147, 1149 1150, 1152, 1164, 1168, 1169, 1171, 1175, 1181, 1199, 1200, 1204, 1214, 1219, 1223 Lycoperateon pimpinellifolium, 1177 Maire, 1158, 1159, 1160, 1161, 1162, 1183 Malcomia bicornis, 1200 Malcomia maritima, 1200 Malva borealis, 1186 Malvaceae, 1186, 1216, 1218 Malva crispa, 1186 Malva mauritiana, 1186 Malva sylvestris, 1186 Malea verticillata, 1186 Maltestrum capense, 1186 Manihot sp., 1219 Manila hemp plant, 1193 Marrow, 1190 Matthiola incana, 1176, 1177 Medicago arabica, 1180 Medicago hispida, 1180 Medicago lupulina, 1189, 1191 Medicago satira, 1151, 1153, 1181, 1190, 1191 Melilofus alba, 1180, 1188, 1189, 1190,

Melilotus indica, 1180

Melon, rock, 1190

Millet, 1162

Melilotus officinalis, 1180

Millet, pearl, 1183 Miscanthus sinensis, 1193 Modrola decumbens, 1196 Moraceae, 1151, 1201 Mung bean, 1189 Musaceae, 1193 Musa textilis, 1193 Muskmelon, 1173 Mustard, 1176, 1199 Mustard, black, 1176, 1177 Mustard, leaf, 1176 Mustard, white, 1176, 1177 Mustard, wild yellow, 1176 Nasturtium officinale, 1177 Nectarine, 1196 Nepeta cataria, 1173 Nestia panteulata, 1177 New Zealand spinach, 1146 Nicotiana alata, 1216 Nicotiana bigelovii, 1177 Nicotiana glauca, 1154, 1167, 1199 Nicotiana glutinosa, 1149, 1150, 1152, 1154, 1166, 1168, 1169, 1177, 1200, 1216 langsdorffii, 1168, 1169. Nicoliana 1177, 1201 Nicoliana palmeri, 1199 Nicotiana repanda, 1177 Nicotiana rustica, 1149, 1154, 1155, 1156, 1177, 1199, 1201, 1216 Nicotiana sylvestris, 1166, 1177 Nicotiana tabacum, 1147, 1149, 1150, 1154, 1164, 1168, 1169, 1171, 1172, 1174, 1175, 1177, 1181, 1199, 1200, 1201, 1212, 1213, 1214, 1216, 1218, 1223 Nicotiana trigonophylla, 1154

Nreotiana triyonophylla, 1184 Nightshade, black, 1147, 1214 Oat, 1160, 1161, 1162, 1192 Oat, wild, 1161 Ocean spray, 1207 Oleaceae, 1187 Onion, 1184 Orange, 1210

Orange, sour, 1292 Ornithogalum thyrsoides, 1184 Orgas sativa, 1160, 1162 Parhyrhssus crosus, 1188 Panicum dichotomyforum, 1183 Panicum miliaceum, 1160, 1162 76. Pseudomonas lachrymans (Smith and Bryan) Carsner. (Bacterium lachrymans Smith and Bryan, Jour. Agr. Res., 5, 1915, 466; Carsner, Jour. Agr. Res., 16, 1918, 15; Bacullus lachrymans Holland, Jour. Bact., 5, 1920, 218; Phytomonas lachrymans Bergey et al., Manual, late ed., 1923, 1841.) From Latin, causing tears, probably referring to the opaque drops formed on the lesion caused by this pathogen.

Synonym Elliott (Man Bact, Plant Pathogens, 1930, 147) lists the following as a synonym Bacillus burgeri Potebina, Khartov Prov. Agr. Evp. Sta., 1, 1915, 37.

Description from Smith and Bryan (loc. cit.) and Clara (Cornell Agr. Exp. Sta. Mem. 159, 1934, 26).

Rods: 08 by 1 to 2 microns Motile with 1 to 5 polar flagella Capsules Grom-negative.

Green fluorescent pigment produced in

Gelatin: Liquefied.

Reef-pertone agar colonies Circular, smooth, glistening, transparent, whitish, entire margins

Broth: Turbid in 24 hours White precipitate with crystals.

Milk: Turns alkalino and clears.

Nitrites not produced from nitrates.

Indole reaction weak.

No H<sub>2</sub>S produced

Not lipolytic (Starr and Burkholder, Phytopath., 32, 1912, 601).

Acid but not gas from glucose, frunctose, mannose, arabinose, syloise, sucrose and mannitol. Alkaline reaction from salts of citric, make and succente acid Maltose, rhamnose, lactose, raffinose, glycerol and sahem not fermented (Clara, loc. ct.).

Starch partially digested. Not digested (Clara, loc. cit.)

Growth in 3 per cent salt after 12 days No growth in 4 per cent salt.

Optimum temperature 25° to 27°C. Maximum 35°C. Minimum 1°C

Aerobic. Facultative anterobe (Clara, loc. cit ).

Source: Isolated from diseased cucumber leaves collected in New York, Wisconsin, Indiana and in Ontario, Canada. Habitat: Pathogenic on eucumber, Cucumus sativus. and related plants.

77. Pseudomonas maculicola (McCulloch) Stevens (Bacterium maculicolum
McCulloch, U S. Dopt. Agr. Bur. Plant
Ind. Bul., 225, 1911, 14; Stevens, The
Funtg which cause Plant Diseases, 1913,
28, Phytomonas maculicola Bergey et al.,
Manual, 1st ed., 1923, 1893, Bacterium
maccullochianum Burgwitz, Phytopathogenie Bacteria, Leningrad, 1935, 77)
From L maculus, spot; cola, dweller,

Rods 09 by 15 to 3 microns. Filaments present. Motile with 1 to 5 polar

flagella Gram-negativo.

Green fluoreseent pigment produced in culture.

Gelatin: Liquefied.

Beef-peptone agar colonies: Whitish, circular, shining, translucent, edges entire.

Broth Turbid No ring or pellicle.
Milk Becomes alkaline and clears
Nitrites not produced from nitrates
Indole production feeble

No H.S formed

Not hipolytic (Starr and Burkholder, Phytopath, 52, 1942, 601)

Acid from glucose, galactises, x) lose, sucrose, glycerol, and mannitol. Alkaline reaction from salts of citric, malic, malonic, and succinic acid. Salicin, maltose, and salts of hippuric and tartaric not utilized (Burkholder).

Slight growth in broth plus 4 per cent salt (Erw Smith, Bact Plant Diseases, 1920, 306).

Aerobic

Optimum temperature 21° to 25°C. Maximum 20°C. Minimum 0°C.

Source: Isolated from diseased cauliflower leaves from Virginia.

Habitat: Pathogenic on cauliflower and cabbage.

Note: Bacterium maculicola var. japonicum Takimoto, Bul. Sci. Fak. Terkult Viruses, Plant Hosts of (continued) Rubus loganobaccus, 1206 Rubus eccidentalis, 1195, 1206 Rubus parviflorus, 1194 Rudbeckia hirta, 1155 Rutabaga, 1177, 1221 Rutaceae, 1202, 1210 Rye, 1160, 1161, 1162, 1192 Sacrharum narenga, 1183 Saccharum officinarum, 1157, 1153, 1159, 1161, 1183, 1208 Salad chervil, 1176 Samolus floribundus, 1199 Sandal, 1149, 1109 Santalaceae, 1149, 1198 Santalum album, 1149, 1193 Sapindacese, 1149 Scrophulariaceae, 1191, 1212, 1214 Secale cereale, 1160, 1161, 1162, 1192 Senecio vulgaris, 1378 Setaria mendis, 1162 Shepherd's purse, 1176 Sidalcea candida, 1186 Sida mollis, 1186 Sida napaca, 1186 Sieva bean, 1168 Sinapis alba, 1177 Sincamas, 1188 Sisymbrium altissimum, 1177 Sisymbrium officinale, 1177 Soja max, also see Glycine soja, 1168, 1180 Solanaceae, 1147, 1149, 1150, 1152, 1154, 1155, 1164, 1166, 1167, 1168, 1169, 1171, 1172, 1173, 1174, 1175, 1177, 1181, 1199, 1200, 1203, 1204, 1212, 1213, 1214, 1216, 1218, 1219, Selanum dulcamara, 1175, 1201, 1214 Solanum melongena, 1147 Solanum nigrum, 1147, 1168, 1169, 1174, 1175, 1214 Solanum tuberosum, 1149, 1150, 1155, 1172, 1174, 1175, 1181, 1199, 1200, 1203, 1204, 1212, 1214 1223 Solanum villosum, 1204 Sonchus asper, 1173 Sorbus pallescens, 1194 Sorghum, 1183

Sowbane, 1199

Sow-thistle, prickly, 1178 Soybean, 1168, 1180, 1190 Speedwell, 1214 Spinach, 1173, 1177, 1178, 1191, 1201 Spinacia oleracea, 1177, 1178, 1191, 1200, 1204 Squash, 1219 Squash, summer crooknerk, 1200 Stachytarpheta indica, 1150 Stellaria media, 1191, 1220 Stock, 1176, 1177 Strawberry, 1195, 1207, 1208 Sudan grass, 1183 Sugar beet, 1149, 1199 Sugar cane, 1157, 1158, 1159, 1160, 1161, 1183, 1208 Swede, 1177 Sweet clover, annual yellow, 1180 Sweet clover, white, 1180, 1188 Sweet clover, yellow, 1180 Sweet pea, 1178, 1179, 1180, 1187, 1190 Sweet potato, 1202 Synedrella nodiflora, 1218 Syntherisma sanguinale, 1183 Tepary bean, 1180 Thiaspi arvense, 1177 Tobacco, 1147, 1149, 1150, 1154, 1164, 1166, 1168, 1169, 1170, 1171, 1172, 1173, 1174, 1175, 1177, 1181, 1200, 1213, 1214, 1216, 1218, 1223 Tomato, 1147, 1149, 1150, 1152, 1164, 1166, 1163, 1169, 1171, 1175, 1181, 1199, 1200, 1204, 1214, 1219, 1223, 1221 Toyon, 1194 Tree tobacco, 1167 Trefoil, haresfoot, 1190 Trifolium agrarium, 1180 Trifolium arvense, 1190 Trifolium varolinianum, 1180 Trifolium cernuum, 1190 Trifolium dubrum, 1180 Trifolium fragiferum, 1100 Trifolium glameratum, 1180, 1190. Trifoleum hybridum, 1180, 1187, 1189, 1190, 1191 incarnatum, 1156, 1157, Trifolium 1180, 1181, 1187, 1189, 1190, 1191

Plum, wild, 1152 Viruses, Plant Hosts of (continued) Poa pralensis, 1160 Parsley, 1176 Parsnip, 1146 Pokeweed, 1193 Paspalum boscianum, 1183 Polygonaceae, 1199 Passiflora alba, 1193 Polygonum pennsylvanicum, 1199 Potato, 1149, 1150, 1155, 1156, 1172, Passifloraceae, 1193 Passiflora coerulea, 1193 1174, 1175, 1181, 1182, 1199, 1200, Passiflora edulis, 1193 1203, 1204, 1214, 1223 Passion fruit, 1193 Primulaceae, 1199, 1201 Primula sp , 1201 Pea, 1178, 1179, 1180, 1188, 1189, Privet, 1187 1190, 1191, 1223 Peach, 1148, 1152, 1158, 1196, 1197. Prune, 1196, 1208 1207, 1208 Prunus americana, 1152 Prunus armeniaca, 1152, 1196 Peanut, 1187 Pear, 1211 Prunus avium, 1196, 1197, 1198, 1210 Pelargonium hortorum, 1168, 1199 Prunus cerasus, 1152, 1197 Pennisetum glaucum, 1183 Prunus communis, 1152, 1196 Pepper, 1164, 1171, 1173, 1175, 1181. Prunus domestica, 1152, 1196, 1198, Periwankle, 1149, 1150, 1152 Prunus emarginala, 1197 Petroselinum hortense, 1176 Prunus mahaleb, 1197 Pe tesi, 1176 Prunus persiea, 1148, 1152, 1158, Petunia, 1171, 1175, 1200 1196, 1197, 1207, 1208 Petunia sp., 1171, 1175, 1177, 1200. Prunus pumila, 1152 Prunus salierna, 1148, 1197 1212, 1216 Phaseolus acutifolius, 1179, 1180 Prunus serrulata, 1197, 1198, 1210 Phaseolus aureus, 1179, 1189, 1191 Prunus sp., 1148, 1207 Phaseolus colcaratus, 1179 Prunus virginiana, 1152 Phaseolus Iunaius, 1168, 1179, 1188 Pyrus communis, 1211 Phaseolus sulgaris, 1168, 1169, 1179, Pyrus malus, 1194 1180, 1181, 1189, 1190, 1191, 1216, 1219 Radicula palustris, 1177 Phenomenal berry, 1206 Radish, 1176, 1200 Photinia arbutifolia, 1191 Raouncula ceae, 1158. 1177, 1200, Physalis alkekengi, 1214 1216 Physolis heterophylla, 1171, 1173 Ranunculus assaticus, 1216 Physalis subglabraia, 1173 Rape, 1176, 1177, 1221 Phytolacca americana, 1199 Raphanus raphanistrum, 1176 Phytolaccaceae, 1173, 1199 Raphanus sattrus, 1176, 1177, 1200 Phytolacea decandra, 1173 Raspberry, 1195, 1205 Pincapple, 1223 Raspberry, black, 1195, 1206 Pisum satieum, 1178, 1179, 1180, 1188. Rhamneae, 1149 1189, 1190, 1191, 1223 Ribgrass, 1161 Plantaginaceae, 1161, 1199 Rice, 1160, 1162 Plantago lanccolata, 1161 Robinia pseudoacacia, 1150 Plantago major, 1161, 1199 Rosaceae, 1148, 1152, 1158, 1194, 1195, 1196, 1197, 1198, 1205, 1206, Plantago rugelii, 1161 Plantago sp., 1166 1207, 1208, 1211 Plantain, 1199 Rosa species and hybrids, 1191 Plum, 1152, 1196, 1208 Rose, 1194

Rubus idarus, 1195, 1205

Plum, Jaronese, 1148, 1197

Viruses, Vectors of (continued) Aphis graveolens, 1177 Aphie laburni, 1187 Aphis leguminosae, 1187 Aphis maidis, 1174, 1183, 1184 Aphis medicaginis, 1179 Aphis middletonii, 1176, 1177, 1200 Aphis rhamni, 1171, 1172 Aphis rubicola, 1205 Aphis rubiphila, 1205 Aphis rumicis, 1176, 1178, 1179, 1180. Aphis sp., 1193 Aphis spiraeae, 1207 Aphia spiraecola, 1179 Aphis tulipae, 1182 Aulacorthum solant, 1204 Balclutha mbila, 1159 Bedbug, 1259 Bemissa gossypsperda, 1218, 1219 Bemisia nigeriensis, 1219 Brevicoryne brassicae, 1177, 1179, 1201 Capitophorus fragaefolsi, 1208 Capitophorus fragariae, 1195 Capitophorus tetrahodus, 1206 Carneocephala fulgida, 1153 Carneocephala triguttata, 1153 Carolinara cypers, 1183 Cavariella capreae, 1176, 1177 Choerostrongylus pudendotectus, 1269 Cicadellidae, 1145, 1147, 1148, 1150, 1153, 1154, 1155, 1157, 1159, 1160, 1161, 1220 Creadula bimaculata, 1159 Cicadula divisa, 1147 Cicadula sexnolata, 1147 Cecadulina mbila, 1159 Cicadulina storeys, 1159 Cicadulina zeae, 1159 Cimex lectularius, 1259 Cimidae, 1259 Convolvulaceae, 1149, 1150, 1165, 1170, 1173, 1192, 1199, 1220 Ctenopsylla felis, 1246 Cuerna occidentalis, 1153 Culex pipiens, 1230, 1252 Culex tarsalis, 1252 Culicidae, 1230, 1252, 1251, 1259, 1266, 1267

Cuscuta californica, 1173, 1198, 1199 Cuscula campestris, 1149, 1150, 1152. 1165, 1170, 1173, 1192, 1199, 1220 Cuscula subinclusa, 1173, 1199 Delphacinae, 1157 Delphax striatella, 1162 Deltocephalus dorsalis, 1160, 1161 Deltocephalus streatus, 1161 Dermacentor andersoni, 1254 Demacentor silvarum, 1250 Dermacentor variabilis, 1252, 1254 Dodders, 1147, 1149, 1150, 1152, 1165, 1170, 1173, 1192, 1199, 1220 Draeculacephala minerra, 1153 Draeculacephala portola, 1161 Eriophyes ribis, 1203 Eriophyidae, 1203 Euscelis striatulus, 1150 Eulestix tenellus, 1220 Flea, 1246 Frankliniella insularis, 1223 Frankliniella lycopersici, 1223 Frankliniella moultoni, 1223 Frankliniella occidentalis, 1223 Franklinzella schultzer, 1223 Fulgoridae, 1145, 1157, 1161, 1162 Gonzordes dissimilis, 1280 Haemaphysalis concinna, 1250 Haematopinidae, 1233 Haematopinus suis, 1233 Haemogogus capricorni, 1266 Helochara delta, 1153 Hyalopterus atriplicis, 1179 Hysteroneura setariae, 1183 Illenoia solanifolii, 1179, 1182, 1183 Izodes persulcatus, 1250 Izodes ricinus, 1249 Ixodidae, 1240, 1250, 1252, 1251 Leafhoppers, 1145, 1146, 1147, 1148, 1150, 1153, 1154, 1155, 1156, 1157, 1159, 1160, 1161, 1162, 1220 Lipaphis pseudobrassicae, 1201 Lumbricidae, 1269 Lygus pratensis, 1222 Macropsis trimaculata, 1113 Macrosiphum ambrosiae, 1179 Macrosiphum pei, 1171, 1178, 118 1181, 1182, 1203 Macrosiphum Islii, 1185 Macrosiphum pelargonii, 1182

Viruses, Plant Hosts of (continued) Trifolium pratense, 1155, 1179, 1187, 1189, 1190, 1191 Trifolium procumbens, 1180 Trifolium reflexum, 1180 Trifolium repens, 1188, 1189, 1190, Trifolium suaveolens, 1180 Triticum sp., 1160, 1161, 1162, 1192 Tropacolum majus, 1224 Tulip, garden, 1182 Tulipa clusiana, 1182 Tulipa eichleri, 1182 Tulipa gesneriana, 1182 Tulipa greigi, 1182 Tulipa linifolia, 1182 Turnip, 1176, 1177 Ulmus americana, 1154 Umbelliferae, 1147, 1176, 1199, 1200 Urticaceae, 1154 Vaccinium macrocarpon, 1150 Vaccinium exycoccus, 1150 Vegetable marrow, 1173 Verbenaceae, 1150 Vernonia cineria, 1213 Vernonia sodocalyz, 1218 Veronica ap , 1214 Vetch, common, 1180 Vetch, harry, 1190 Vetch, spring, 1179 1'iera faba, 1179, 1180, 1187, 1189, 1100, 1101 l'icia satua, 1179, 1180, 1189, 1191 Victa rillosa, 1190 1'igna sinensis, 1169, 1173, 1188, 1189, 1212 Vinca rosea, 1149, 1150, 1152 Violaceae, 1200 l'iola cornuta, 1200 Vitaceae, 1153, 1198 L'atta rinifera, 1153, 1108 Wallflower, 1177 Water pimpernel, 1199 Watermelon, 1167 Wheat, 1160, 1161, 1162, 1192, 1202 Windflower, vernal, 1158 Yam bean, 1188

Zea mays, 1158, 1159, 1161, 1162, 1183

Zonnia, 1147, 1169, 1174, 1181

Zinnia elegans, 1147, 1169, 1174, 1177, Ziziphus cenoplia, 1149 Viruses, Vectors of, Aceratagallia curvaia, 1155 Aceratagallia lurata, 1155 Aceratagallia obscura, 1155 Aceratagallia sanguinolenta, 1155 Aèdes aequati, 1230, 1254, 1255, 1259, 1266 Aëdes albopictus, 1254 Aedes apico-annulatus, 1266 Ačdes atropalpus, 1254 Aēdes cantator, 1254 Aèdes dorsalis, 1254 Aedes fluviatilis, 1266 Aedes leucocelaemus, 1266 Aedes Introcephalus, 1266 Aedes nigromaculis, 1254 Aeder scapularis, 1266 Aedes sollicitans, 1254 Aedes stimulans, 1230 Aedes taeniorhynchus, 1254 Aedes triseriatus, 1254 Aēdes vezans, 1230, 1254 Agallia constricta, 1156 Agailta quadripunctata, 1156, 1156 Agalliana ensigera, 1220 Agalliopsis novella, 1155, 1158, 1157 Aleyrodidae, 1218, 1219 Allolobophora caliginosa, 1269 Amblycephalinae, 1153 Amphorophora rubi, 1190 Amphorophora rubicola, 1196 Amphorophora sensoriata, 1196 Anuraphis tulipae, 1182 Aphididae, 1163, 1164, 1171, 1172, 1173, 1174, 1175, 1176, 1177, 1178, 1179, 1180, 1181, 1182, 1183, 1184, 1185, 1187, 1188, 1193, 1195, 1196, 1200, 1203, 1204, 1205, 1206, 1207, 1208, 1211 Aphids, see Aphididae Aphie abbreviata, 1172, 1175, 1204 Aphie apigrateolens, 1176, 1177, 1200 Aphie apii, 1176, 1200 Aph: fabae, 1171, 1201 Aphie ferruginea etriata, 1176. 1200 Aphia goszypii, 1173, 1174, 1176, 1177, 1179, 1185, 1188, 1200, 1211

Water (continued) Granulobacillus, 826 Hyphomicrobium, 837 Lamprocystis, 847 Lampropedia, 844 Leptospira, 1077, 1078, 1079 Leptothrix, 984, 985, 986, 995 Leuconostoc, 348 Macromonas, 1001 Methanobacterium, 646 Micrococcus, 240, 245, 246, 250, 251, 255, 256, 257, 258, 259, 261, 262, 270 271, 273, 274, 276, 277, 278, 280, 281, 605 Microspira, 202 Naumanniella, 834 Nevskia, 830 Nocardia, 908 Paracolobactrum, 460 Pastourella, 551 Pelodiciyon, 871, 872 Prolaminobacler, 190 Proteus, 491 Pseudomonas, 89, 90, 91, 93, 96, 97, 99, 100, 101, 102, 103, 104, 145, 146, 147, 148, 149, 173, 174, 175, 176, 178, 179, G97, G98, 701 Rhabdomonas, 854, 855 Rhodococcus, 231 Rhodopseudomonas, 864, 865, 866 Rhodospirillum, 868 Rhodothere, 855 Salmonella, 501 Saprospira, 1055 Sarcina, 287, 288, 291, 293, 294 Serratia, 481, 482, 483, 484, 485 Siderocapsa, 833, 831 Siderococcus, 835 Siderocystis, 835 Sideroderma, 835 Sideromonas, 831 Siderothece, 835 Sphaerotilis, 982, 983 Spirillum, 213, 214, 218, 701 Spirochaeta, 1052, 1053, 1054, 1079 Streptococcus, 337, 338, 339, 341, 345, Terminosporus, 823 Thiobacillus, 79,81 Thiocapsa, 845

Thiocystis, 847 Thiodictyon, 845 Thionema, 995 Thiopedia, 843 Thioploca, 994 Thiopolycoccus, 850 Thiosarcina, 813 Thiosiphon, 995 Thiospirillopsis, 993 Thiospirillum, 850, 851, 852, 853 Thiothece, 846 Thiothrix, 989, 990 Thiovulum, 1000 Vibrio, 198, 199, 201, 202, 203, 201, 205. 703 Water, Source Aachen, Germany, 831 Arctic Ocean, 857 Black Sea, 1002 Breslau, 834 Caucasus, 832 Crimes, 845 Czechoslovakia, 835 Finland, 835 Florida, 845 Frankfurt, Germany, 841 Germany, 835 Graz, Austria, 855, 857, 853 Minneapolis, Minnesota, 830 Nikko, Japan, 859 Petschora Sea, 832 Russia, 835 St. Petersburg, 830 Sweden, 835 Sweden, Aneboua region, 832, 833, 831, 835, 969, 983, 986 Teufelsee, 831 United States of America, 835 White Sea, 832 Worms, Germany, 831 Waters, also see River Water, Spring Water, Sea Water and Tap Water Borax yielding water Sarcina, 294 Bottled mineral waters Bacillus, 657

Bacterium, 673

Proteus, 491

Micrecoccus, 695

Viruses, Vectors of (continued) Macrosiphum pisi, 1179, 1180, 1181, 1128 Macrosiphum solonifolii, 1164, 1171. 1173, 1178, 1179, 1180, 1181, 1182, 1183, 1185, 1188, 1193, 1203, 1204 Macrosteles divisus, 1147 Water Metastrongylidae, 1269 Metastrongylus elongatus, 1269 Miridae, 1221, 1223 Moonia albimaeulata, 1150 Mosquito, 1230, 1232, 1234, 1259. 1266, 1267, 1277 Myzus circumflexus, 1164, 1171, 1173, 1176, 1177, 1185, 1200, 1204 Myzus canvolvuls, 1176, 1200, 1204 Myzus fragaefolii, 1195, 1207 Myzus persicae, 1164, 1171, 1173, 1175, 1176, 1177, 1178, 1179, 1182, 1183, 1185, 1193, 1200, 1201, 1203, 1201 Myrus pseudosolans, 1164, 1173, 1201 Neokolla erreellata, 1153 Neokolla confluens, 1153 Neokolla gothica, 1153 Neokolla herroglyphica, 1153 Nephotettix apicalis, 1160 Nephatettix bipunctatus, 1100 Ophiola etriatula 1150 Penlalonia nigronergasa, 1174, 1193 Peregrinus maidis, 1101 Perkinsiella saceharicida, 1157 Perkinsiella vastatrix, 1157 Philopteridae, 1280 Piesma cinerea, 1221 Piesma quadrata, 1221 Piesmidae, 1221 Pulicldze, 1216 Reduviidae, 1251 Rhipicephalus appendiculatus, 1249 Rhapalouphum melliferum, 1176, 1177, Rhopalosiphum prunifoliae, 1184 Rhopalosiphum pseudobrassicae, 1177. Taemerhynchus brevipalpis, 1267 Thamnolettix argentata, 1148, 1151 Thamnolettix geminalus, 1147 Ferribacterium, 831 Thampotettix montanus, 1147 Flarobacterium, 429, 431, 433, 431, 435. Thripidae, 1223 436, 437, 438, 439, 410, 441, 412, 614 Thrips tabaer, 1223 Gallionella, 831, 832

Tick, American dog, 1252 Texeptera aurantis, 1202 Toxoptera gramtnum, 1183 Triatoma sanguisuga, 1254 White flies, 1218, 1219

Achramatsum, 999 Achromobacter, 418, 419, 423, 424, 425, 426, 427 Actinomyces, 968, 970, 972 Aerobacter, 456, 457, 692 Alcaligenes, 414 Amoebobacter, \$40, 850 Ascobacterium, 647 Ascococcus, 250 Azotobacter, 221 Bacillus, 612, 613, 644, 645, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 650, 661, 661, 665, 666, 667, 668, 669, 670, 671, 672, 693, 715, 721, 722, 723, 725, 726, 732, 733, 734, 736, 737, 738, 740, 742, 741, 746, 747, 748, 749, 752, 751, 755, 750, 757, 758, 813, 814, 815, 810, 817, 818, 819, 825 Bacterium, 602, 603, 613, 641, 673, 674, 675, 676, 677, 678, 670, 680, 681, 682, 684, 683, 686, 688, 689, 690, 758, 760 Blastocaulis, 836 Caulobacter, 833 Cellulomonas, 620 Chlorobacterium, 873 Chicrobium, 870 Chlorochromatium, 873 Chromateum, 837, 858 Chromobacterium, 232, 233, 234 Clathrochloris, 872 Clonothrix, 983 Clostredium, 821 Corynebacterium, 397, 403, 401 Crenothers, 987 Cylindrogloca, 871 Denulfocibrio, 208 Diplococrus, 091 Eperythrosoon, 1115 Escherichia, 419, 450

| Water (andiment)                   | Thiocapsa, 845                         |
|------------------------------------|--|
| Waters (continued)                 | Thiocapsus, 847                        |
| Stagnant (continued)               | Thiodictyon, 816                       |
| Chlorobium, 870                    |  |
| Chlorochromatium, 873              | Thionema, 995<br>Thiopedia, 843        |
| Clathrochloris, 872                |  |
| Cylindrogloca, 874                 | Thiopolycoccus, 850                    |
| Lamprocystis, 848                  | Thiosarcina, 843                       |
| Lampropedia, 844                   | Thiospirillopsis, 993                  |
| Pcladictyon, 871, 872              | Thiospirillum, 851, 852                |
| Pseudomonas, 149                   | Thiothece, 846                         |
| Rhabdomonas, 854, 855              | Thiothrix, 989, 990                    |
| Rhodopseudomonas, 864, 865, 866    | Thiovulum, 1000                        |
| Rhodospirillum, 868                | Sulfur, stream containing              |
| Rhodothece, 855                    | Macromonas, 1001                       |
| Sphaerotilis, 982                  | Surface                                |
| Spirillum, 213, 214, 216, 217      | Paracolobactrum, 460                   |
| Thiocapsa, 845                     | Swamp                                  |
| Thiocystis, 847                    | Bacillus, 659, 813, 814, 816, 817, 815 |
| Thiodictyon, 846                   | Lampropedia, 844                       |
| Thiopedia, 843                     | Leptothrix, 986                        |
| Thropolycoocus, 850                | Methanococrus, 285                     |
| Thiosarcina, 843                   | Sideromyccs, 986                       |
| Thiospirillum, 851, 852            | Sphaeratilis, 983                      |
| Thiothece, 846                     | Spirochaeta, 1053                      |
| Thiothriz, 989                     | Tap waters, see Tap Waters             |
| Streams, paper mill waste polluted | Trickling filter                       |
| Sphaerotilis, 982                  | Pseudomonas, 177, 178                  |
| -, sewage polluted                 | Vibrio, 206                            |
| Sphaerotitis, 982, 983             | Unfiltered water                       |
| Submerged surfaces                 | Pseudomonas, 90, 97                    |
| Caulobacter, 833                   | Waste                                  |
| Gallionella, 832                   | Bacillus, 742, 744, 758                |
| Leptothrix, 985                    | Waste from sugar factory               |
| Siderocapsa, 834                   | Sarcina, 293                           |
| Sideromonas, 834                   | Wells, in chalk region                 |
|                                    | Flavobacterium, 429                    |
| Sulfur<br>Achromatium, 999         | Well water                             |
| Amoebobacter, 849, 850             | Bacillus, 815                          |
| Amoedoudeter, das, dos             | Chromobacterium, 233, 234              |
| Bacterium, 685                     | Lampropedia, 844                       |
| Beggiatoa, 992, 993                | Leuconostoc, 345                       |
| Chlorobium, 870                    | Pseudamanas, 101                       |
| Chlorochromatium, 873              | Serratia, 484                          |
| Clathrocystis, 872                 | Throspirillum, 853                     |
| Cylindrogloca, 874                 | Water Works                            |
| Lamprocystis, 848                  | Clonothrix, 983                        |
| Microbacillus, 690                 | Croutenant,                            |
| Pelodictyon, 871, 872              | Wine                                   |
| Rhabdomonas, 854, 855              | Acetobacter, 186                       |
| Rhodothece, 856                    | Bacillus, 654, 668, 672, 753           |
| Spirochaeta, 1053                  |  |

| Waters (continued)             | Lake                                   |
|--------------------------------|--|
| Brackish, muddy bottom of      | Chromatium, 857, 858                   |
| Spirillum, 215, 217            | Clostridium, 824                       |
| Brewery, reservoir             | Gallsonella, 831, 834                  |
| Sarcina, 290                   | Micrococcus, 276                       |
| Canal                          | Rhabdomonas, 855                       |
| Bacillus, 655, 672             | Spirochaeta, 1053                      |
| Bacterium, 682, 688            | -, plankton                            |
| Thiobacillus, 81               | Chitin digesting bacteria, 632         |
| Chitin digesting bacteria, 632 | Mineral, also see Bottled, mineral     |
| Cistern                        | Raters                                 |
| Bacterium, 680                 | Micrococcus, 268                       |
| Containing iron                | Peat bog                               |
| Actinomyces, 969               | Sphaerothrix, 986                      |
| Crenothrez, 987                | Pines                                  |
| Gallionella, 831, 832          | Clonothriz, 983                        |
| Leptothriz, 984, 985, 986      | Polluted                               |
| Lieskeela, 986                 | Pseudomonas, 89                        |
| Containing manganese           | Pond                                   |
| Lepfothrix, 055                | Chromatium, 857, 858                   |
| Creamory waste filter          | Gallionella, 831, 834                  |
| Pseudomonas, 177, 178          | Leptospira, 1077                       |
| Creek                          | Macromonas, 1001                       |
| Aerobaeter, 458                | Rhabdomonas, 855                       |
| Ditch                          | Sphaerothriz, 986                      |
| Desulfovibrio, 208             | Spirochaeta, 1079                      |
| Pseudomonas, 603               | Pool                                   |
| Drainage                       | Chlamydozoon, 1115                     |
| Bacillus, 749                  | Polyangium, 1032                       |
| Spirochaeta, 1053              | Putrid                                 |
| Liltered                       | Spirillum, 213, 216                    |
| Pseudomonas, 149, 173          | Rain, in bark of poplar tree           |
| Vibrio, 196                    | Spirillum, 217                         |
| Fish batchery                  | River, see River Water                 |
| Achromobacter, 425             | Running water                          |
| Fountain                       | Crenothriz, 937                        |
| Bacillus, 733                  | Leuconostoc, 318                       |
| Fresh water                    | Sphaerotilie, 952                      |
| , lime deposits                | Salt seas and lakes, see Salt Seas and |
| Pseudomonas, 146               | Lakes                                  |
| Spirochaeta, 1052, 1054        | Salt, see Sea Water                    |
| , with algae                   | Slime in mines                         |
| Spirillum, 218                 | Leptospira, 1077                       |
| Prozen, see Hail, Ice and Snow | Snow, see Snow                         |
| Glacial                        | Spring, see Spring Waters              |
| Preudomonas, 145               | Stagnant                               |
| Grossly polluted               | Amoebobacter, 819, 850                 |
| Spirochaeta, 1053              | Bacillus, 667                          |
| Hail, see Hail                 | Bacterium, CS1, CS3, CSS               |
| Ice, see Ice                   | Chlarobacterium, 873                   |



Wine (continued) Bacterium, 362, 673, 684, 689

Lactobacillus, 359, 361, 363 Micrococcus, 251, 259, 267, 280

Pseudomonas, 149

Streptococcus, 345

-, cellars

Micrococcus, 277 Streptococcus, 340

-, slimy

Streptococcus, 340

Yeast

Bacillus, 741

Bactersum, 680, 687 Clostridium, 824

Lactobacillus, 361

Pediococcus, 249, 250 Sarcina, 290, 291, 292, 293, 294

-, baker's

Streptococcus, 336

--, beer

Bacillus, 749

Pediococcus, 249

-, brewer's Flavobacterium, 439

-, distillery

Lactobacillus, 360 —, mash

Pseudomonas, 146

-, pressed
Flavobacterium, 613
Lactobacillus, 358

Kjusu Imp. Univ., 4, 1931, 545 has not been seen.

78. Pseudomonas marginata (McCulloch) Stapp. (Bacterium marginatum McCulloch, Science, 54, 1921, 115; Jour. Agr. Res , 29, 1921, 174; Phytomonas marginata Bergey et al., Manual, 1st ed., 1923, 188; Stapp, in Sorauer, Handhuch der Pflanzenkrankheiten, 2, 5 Auf., 1928. 56.) From L. morginatus, having a border, probably refers to the definite margin of the colony.

Rods: 0.5 to 0 6 hy 0.8 to 1.8 microns. Motile with 1 to 4 hipolar flagella. Capsules. Gram-negative.

Green fluorescent pigment produced in Uschinsky's and Fermi's solutions.

Gelatin: Liquefied.

Agar colonies: White, circular, smooth, translucent, viscid, with definite margins at first thin but later thick and contoured. Surface wrinkled.

Milk: At first slightly acid, then alkaline. Casein digested.

Nitrites not produced from nitrates.

Indole production slight. Hydrogen sulfide production slight. Lipolytic (Starr and Burkholder,

Phytopath., \$2, 1942, 601). Acid hut not gas from glucose, lactose, sucrose and glycerol.

Starch hydrolysis feeble.

Growth in 3.5 per cent salt. No growth in 4 per cent salt. pH range, 4.6 to 9.1. Optimum temperature 30° to 32°C.

Maximum 40°C. Minimum 8° to 9°C. Source: Repeatedly isolated from diseased gladiolus.

Habitat: Pathogenic on Gladiolus spp.

and Iris app.

79. Pseudomonas medicaginis Sackett. (Sackett, Science, 31, 1910, 553; also Colorado Agr. Exp. Sta., Bull. 158, 1910, 11; Bacillus medicaginis Holland, Jour. Bact., 5, 1920, 219; Phytomonas medicaginis Bergey et al., Manual, 1st ed., 1923, 179; Bacterium medicaginis Elliott, Bact. Plant Path., 1930, 162.) From L. medica, ancient Media; M.L. Medicago, a generic name.

Rods: 0.7 hy 1.2 microns. Motile with to 4 flagella. Filaments present. Gram-negative,

Green fluorescent pigment produced in culture.

Gelatin: Not liquefied.

Nutrient agar colonies: Growth in 24 hours whitish, glistening.

Broth: Turhid in 24 hours. Pellicle formed. Viscid sediment.

Milk: Becomes alkaline. No change. Nitrites not produced from nitrates.

Indole not produced. No HaS produced.

Not lipolytic (Starr and Burkholder, Phytopath., 32, 1942, 601).

Starch not hydrolyzed.

No gas from carbohydrates. Acid from sucrose.

Slight growth in broth plus 3.75 per cent salt.

Optimum temperature 28° to 30°. Maximum 37.5°C.

Acrobic.

Source: Isolated from brown lesions on , leaves and stems of alfalfa.

Hahitat: Pathogenic on alfalfa, Medicago sp.

79a. Pseudomonas phaseolicola (Burkholder) Dowson, (Phytomonas medicaginis var. phoseolicola Burkholder, Phytopath., 16, 1926, 915; Bacterium medicaginis var. phaseolicola Link and Hull, Bot. Gaz., 83, 1927, 413; Pseudomonas medicaginis vnr. phaseolicola Stapp and Kotte, Nachrichtenb. f. d. Deutschen Pflanzenschutzdienst, 9, 1929, 35; Dowaon, Brit. Mycol. Soc. Trans., 26, 1943, 10.) From L. phaseolus, hean; M.L. Phaseolus, a generic name; cola, dweller.

puerariae Synonym: Bacterium Hedges. (Phytopath., 17, 1927, 48 and 20, 1930, 140; Phytomonas puerariae Bergey et nl., Manual, 3rd ed., 1930, 267.)

Description from Burkholder and Zaleski (Phytopath., 22, 1932, 85).

## INDEX OF THE NAMES OF GENERA AND SPECIES\*

(For Index of the Names of Orders, Families, Genera and Groups of Intermediate Rank, See Table of Contents, p. XI.)

abaca (Marmor), 1193 abbreviatum (Chloronostoe), 870 aberdeen (Salmonella), 526 abony (Salmonella), 502 aboriginalis (Spirochaeta), 1065 abortginalis (Spiroschaudinnia), 1065 aborioinalis (Treponema), 1065 abortivus (Bacillus), 506 aborticus equinus (Bacillus), \$06 abortum-equi (Bacterium), 506 abortus (Alcaligenes), 561 abortus (Bacillus), 561, 562 abortus (Bacterium), 561, 562 abortus (Brucella), 43, 561, 562 abortusbovis (Salmonella), 435, 502, 507 abortus canis (Salmonella), 530 abortus endemici (Corynebacterium), 561 abortus equi (Bacillus), 506 abortus equi (Salmonella), 403, 506 abortus-equi (Streptococcus), 336 abortus equinus (Bacillus), 506 abortus ovis (Bacterium), 506 abortusovis (Salmonella), 493, 495, 506 abortus suis (Bacillus), 562 abortus var. lipolyticus (Bacillus), 390 abortus var. lipolyticus (Bacterium), 330 abscessus (Actinobacterium), 928 abundans (Mycothrix), 983 abutilon (Marmor), 1186 abysseus (Bacillus), 736 منع فرأتا عالم والتسافية

aaser (Streptothrix), 976

aceria (Achromobacter), 456 aceris (Bacillus), 456 aceris (Phytomonas), 113 aceris (Pseudomonas), 113 acernea (Phytomonas), 165 acernea (Pseudomonas), 165 accrnes (Xauthomonas), 165 aceti (Acetobacter), 179, 181, 183, 692 aceti (Bacillus), 181, 182, 761 aceti (Bacteriopsis), 181 aceti (Bacterium), 179, 181 aceti (Micrococcus), 181 aceti (Mycoderma), 181 aceti (Termobaeterium), 185 aceti (Torula), 181 aceti (Ulvina), 181 aceti (Umbina), 181 Acetobacter, 9, 18, 21, 23, 25, 29, 31, 43, 179, 180

179, 189
Actobacterium, 18, 179
acetobutyheum (Clostridium), 780, 805, 825
acetobutyricum (Clostridium), 780, 807
acetobutyricum (Bacillus), 721
acetoethylicus (derobacillus), 721

acctogenes a (Bacillus), 352

<sup>\*</sup>Index prepared by Prof. Robert S. Breed and Mrs. Margaret E. Breed, New York State Experiment Station, Geneva, New York, June, 1947.

aeris-minutissimum (Bacterium), 672 aerius (Micrococcus), 251 Aerobacillus, 20, 22, 27, 23, 30, 31, 720, 737 Aerobacter, 10, 21, 26, 30, 31, 37, 443, 448, Aerothriz, 929 463.464

Aerobacteroides, 27 aerobius (Bacillus), G17, 650, 737 aerobius (Streptococcus), 239 aerofaciens (Bacteroides), 362, 363 aerofaciens (Eubacterium), 368 aerofoetidum (Clostridium), 781 aerofoctidus (Hacillus), 781 aerofoctidus (Seguinillus), 781 acrogenes (Acidobacterium), 351 scrogenes (Aerobacter), 414, 454, 456, 457,

400, 602 aerogenes (Bacillus), 451, 617, 659 acrogenes (Bacterium), 451, 672 Aerogenesbacterium, 11, 453 aerogenes I and II (Bacterium), 672 aerogenes (Colobactrum), 454 aerogenes (Encapsulata) (Bacillus), 454 aerogenes (Helicobacterium), 630 aerogenes (Micrococcus), 246, 251 aerogenes (Plocamobacterium), 361 aerogenes (Staphylococcus), 216 aerogenes (Streptococcus), 336 aerogenes (Welchillus), 790 aerogenes-capsulatum (Clostridium), 790 aerogenes capsulatus (Bacillus), 789, 790 aerogenes capsulatus (Bacterium), 790 aerogenes gangrenosae (Bacillus), 813 aerogenes meningitidis (Bacillus), 662 aerogenes necrosans (Bacillus), 820 aerogenes sputigenus capsulatus (Bacillus), 617, 6S6

aerogenes vesicae (Baeillus), 653 aerogenes vesicae (Bacterium), 653 aerogenes vesicae (Coccobacillus), 653 acrogenoides (Paracolobactrum), 460, 490 aerogenosus (Bacillus), 126 Aeromonas, 29, 30, 101 scrophilum (Achromobacter), 810 aerophilum (Bacterium), 737 aerophilum (Urobacterium), 610, 691 aerophilus (Bacillus), 737 aerophilus (Streptocoecus) 336

aero-tertius (Bacillus), 812, 827 aerothermophilus (Bacillus), 731 aertrycke (Bacillus), 502 aerlrycke (Bacterium), 502 aertrycke (Salmonella), 502 acrirycke var. mcleagridis (Salmonella), 502 aertrycke var. Storrs (Salmonella), 503 aerugineus (Actinomyces), 957 neruginosa (Pseudomonas), 59, 126, 693, 701 aeruginozum (Baeterium), 89 aeruginosus (Bacillus), 89 aeschynomenus (Bacillus), 647 aestuarii (Desulfovibrio), 203, 209 aestuarii (Microspira), 208 aestumarina (Pseudomonas), 697 actatulae (Morator), 1227 aethebius (Bacillus), 647 aethebius (Micrococcus), 266 aethebius (Streptococcus), 266 aevi (Marmor), 1200 afanassiefi (Bacillus), 737 afermentans (Micrococcus), 605 africana (Nocardia), 939 africanus (Actinomyers), 959 africanus (Streptomyces), 959 agalactiae (Borrelomyces), 1293

aerosporus (Bacillus), 720

aggregatum (Chlorochromatium), 859, 873, 874 aggregatum (Pelodictyon), 871, 872, 874 aggregatus (Streptococcus), 308

agalactiae (Capromyces), 1292

agalaxias (Anulomyces), 1292

agarliquefaciens (Vibrio), 200

agarlyticus (Vibrio), 702

agglomerans (Bacillus), 489

agglomeratus (Bacillus), 716

agglutinans (Lactococcus), 336

aggiutinans (Leuconostoc), 346

aggregata † (Sorochloris), 870

agar-excdens (Bacillus), 631

agalactiae (Streptococcus), 319

agar-liquefaciens (Microspira), 200

agalactiae contagiosas (Streptococcus), 319

1 rio). 413 . (Alcaligenes), 416 .s (Bacillus), 116 . .. schacillus). 731 .. will 101, 738 6), 459 Lectel acillus), 363 / ream), 131 Jonas), 131 1, 165 105 105 1. 165 1 1533 + E11 foutterrum), 673 J. 510, 513 337 , 3 1/97 1.16 136 (m), 919 020 er. 931, 917, 968 ~ 5h 718 ....

alpha (Streptothrix), 976 alpha (Tarpeia), 1268 alpinus (Bacillus), 738 altendorf (Salmonella), 506 alternans (Zygoplagia), 13 alutaeca (Pseudomonas), 178 alutacca (Sarcina), 200 alutaceum (Bacterium), 673 alvearis (Cryptococcus), 337 alvearis (Streptococcus), 337 alvei (Bacillus), 723, 721, 728, 715 alveicola (Proteus), 490 alreolaris (Bacillus), 733 alva (Micrococcus), 274 amabilis (Bacillus), 618 amabilis (Bacterium), 618 amager (Solmonella), 521 amaracrylus (Acrobacillus), 720 amaracrylus (Bacillus), 720 amoronthi (Bocterium), 178 amaranthi (Phytomonas), 178 amaronti (Pscudomonas), 178 amarifaciens (Micrococcus), 238 amarificans (Bacillus), 716 amorillae (Bacillus), 618 omarillum (Plectridium), 814 amarus (Bocillus), 619, 733 ambiguo (Eberthella), 536 ambigua (Pscudomonas), 103, 697 ambigua (Shigetia), 836 ambratus (Streptococcus), 337 americana (Cohnistreptothriz), 974 americanum (Clostridium), 819

americanus (Actinomyces), 975 americanus (Nitrospeceus), 71 americanus (Proteus), 490 amerimnus (Bacillus), 613 amersfoort (Salmonetta), 511 amethystina (Pseudomonas), 233 ameliane a serie a serie

albidus (Micrococcus), 251, 277 albidus (Streptococcus), 337 albilineans (Bacterium), 639 albilineans (Phytomonas), 639 alboatrus (Actinomyces), 967 albocereus (Micrococcus), 231, 281 Alboeoccus, 8, 235 albofaciens (Bacillus), 511 albofaciens (Shigella), 511 alboflavum (Prataminobacter), 189, 190 albaflarus (Actinomyces), 954 alboflavus (Streptomyces), 954 albagilva (Cytophaga), 1014 al a-lacteum (Clastridium), 819 albolaelis (Bacillus), 716 alboluteum (Clostridium), 819 albapreesp lans (Bacterium), 142 albaprecipitans (Phytamonas), 142 albaprecipitans (Pseudomanas), 141 albasparca (Nocardia), 951 allosporeus (Actinomyces), 954 albospareus (Streptomyces), 954 alboriridis (Actinomyces), 910, 968 album (Achramobacter), 423 album (Baclerium), 42, 423, 618, 673 album (Citrobacter), 448 album (Carynebacterium), 402 album (Mycobacterium), 890 album liquefacsens (Clostridium), \$19 album minor (Clostridium), 819 album non-liquefaciens (Clostridium), 819 albuminis (Bacillus), 799 albuminis (Bacillus) (Streptobacter), 737 albuminosus (Flexibacter), 38 albuminus (Bacillus) (Streptobacter), 727 albus (Actinomyces), 924, 934, 940, 968 albus (Alcaligenes), 416 albus (Bacillus), 42, 423, 648, 737, 738 albus (Cellulomonas), 737 albus (Galactococcus), 250 albus (Micrococcus), 242, 249, 251, 252, 253, 257, 258, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 272, 273, 274, 275, 276, 277, 279, 280, 281, 347, 691 albus I (Micrococcus), 257 albus II (Micrococcus), 252, 270

albus (Pediocoecus), 249

albus (Proactinomyces), 923 albus (Staphylococcus), 242, 1140, 1141, albus (Streptococcus), 337 albus (Streptomyces), 933, 943, 947, 949 albus var. a (Actinomyces), 934 albus var. acidus (Actinomyces), 915, 934 albus var. cretaceus (Actinomyces), 934 albus var. maltigenes (Micrococcus), 695 albus var. achraleuccus (Actinomyra), 931, 968 albus var. tossica (Actinomyces), 918 albus var. toxica (Actinomyces), 834 albus acidus (Actinomyces), 915, 934 albus anaeraliescens (Bacillus), 643 albus asporogenes (Actinomyces), 968 albus cadateris (Bacillus), 669 albus cadarerís (Ba:terium), 609 albus fluidificans (Micrococcus), 257 albus liquefaciens (Micrococcus), 274 albus liquefaciens (Staphylococcus), 251 albus non liquefaciens (Coccus), 261 albus non liquefaciens (Staphylocoecus). 231 albus putidus (Bacillus), 649 albus putridus (Bacillus), 613 albus urinae (Micrococcus), 279

albus urinae (Micrococcus), 279 albus-vulparis (Actinomyces), 568 alcalescens (Bacillus), 450 alcalescens (Escherichia), 450 alcalescens (Micrococcus), 303 alcalescens (Veillomella), 303 alcalescens var. gingitalis (Veillomella), 304 alcalescens var. minutiesima (Veillomella), 304 alcalescens var. syzygios (Veillomella), 304 alcalescens var. syzygios (Veillomella), 304

alcal factors (Ebertheim), 200 Alcaligencs, 10, 21, 30, 32, 412, 416 alcaligencs (Acuformis), 891 alcaligence (Bacillus), 413 alcaligence (Bacillus), 413 alcaligence (Clostridium), 891 alcaligence (Palmula), 891 alcaligenes (Vibrio), 413 alculinofoctidus (Alcaligenes), 416 alcalinofoetidus (Bacillus), 416 alcalinus (Thermobacillus), 734 alcalophilus (Bacillus), 738 alcia (Klebsiella), 459 alcoholphilus (Lactobacillus), 363 aleuritidis (Bacterium), 131 aleuritidis (Phytomonas), 131 aleuritidis (Pseudomonas), 131 alfalfae (Bacterium), 165 alfalfae (Phytomonas), 165 alfalfae (Pseudomonas), 165 alfalfae (Xanthomonas), 165 algeriense (Bacterium), 673 alginicum (Bacterium), 641 alginovorum (Bacterium), 626 algosus (Vibrio), 702 aliphaticum (Boclersum), 673 aliphaticum liquefaciens (Bacterium), 673 alkalescens (Bacillus), 539 alkalescens (Baclerium), 539 alkalescens (Eberthella), 530 alkalescens (Proshigella), 539 alkalescens (Shigella), 539, 540, 543 allanloicus (Sireptococcus), 337 allantoides (Bacillus), 673 allantoides (Bactersum), 673 aller (Leuconostoc), 346 alliariae (Bacillus), 477 alliariae (Erwinia), 477 allii (Bacillus), 697 allii (Pseudomonas), 145, 697 alliicola (Phylomonas), 136 allifeola (Pseudomonas), 136 allium (Bacterium), 145 alluvialum (Mycobacterium), 919 alma (Cellulomonas), 620 almquisti (Actinomyces), 931, 917, 968 almus (Bacillus), 620 alni (Actinomyces), 968 aloes (Bacterium), 758 alopecuri (Bacıllus), 738 alpha (Bacillus), 618, 738 alpha (Micrococcus), 279 alpha (Ocepora), 931 alpha (Phagua), 1141

alpha (Streptothriz), 976 alpha (Tarpeia), 1268 alpinus (Bacillus), 738 altendori (Salmonella), 506 alternans (Zugaplagia), 13 alutacea (Pseudomonas), 178 alutacea (Sarcina), 200 alulaceum (Bacterium), 673 aluzaris (Cryptococcus), 337 alcearis (Streptococcus), 337 alvei (Bacillus), 723, 724, 728, 745 alveicola (Proteus), 490 alveolaris (Bacillus), 738 alvi (Micrococcus), 274 amabilis (Bacillus), 648 amabilia (Bacterium), 648 amager (Salmonella), 524 amaracrylus (Acrobacillus), 720 amaraerylus (Bacıllus), 720 amaranthi (Baeterlum), 178 amaranthi (Phytomonas), 178 amaranti (Pseudomonas), 178 amarifaciens (Micrococcus), 238 amarificans (Bacillus), 716 amarillae (Bacillus), 648 amarillum (Plectridium), 814 amarus (Bacillus), 648, 738 ambigua (Eberthella), 636 ambigua (Pseudomonas), 103, 697 ambigua (Shigella), 639 ambigua (Spirochaeta), 1085 ambigua (Treponema), 1065 ambiguum (Achromobacter), 103 ambiguum (Bacterium), 536, 673, 697 ambiguus (Bacıllus), 103, 536 ambratus (Streptococcus), 337 americana (Cohnietreptothrix), 974 americanum (Clostridium), 819 americanus (Actinomyces), 975 americanus (Natrosococcus), 71 americanus (Proleus), 430 amerimnus (Bacillus), 648 amersfoort (Salmonella), 511 amethystina (Pseudomonas), 233 amethystinum (Chromobacterium), 232 amethystinus (Bacillus), 232, 233 amethystinus (Bacterium), 232

amethystinus mobilis (Bacillus), 233 amethystinus mobilis (Bacterium), 233 amfareti (Bacterium), 673 amherstiana (Salmonella), 515 aminovorans (Bacillus), 738 ammoniae (Proteus), 490 ammoniae (Salmonella), 490 ammoniagenes (Alcaligenes), 416, 607 ammoniagenes (Bacterium), 416, 607 amocontactum (Flavobacterium), 631 Amoebobacter, 16, 23, 26, 848, 849, 850 Amoebomonas, 8, 25, 848 amphibiae (Spirochaeta), 1065 amphibolus (Vibrio), 702 amplelopsoroe (Bacillus), 227 amplus (Micrococcus), 252 ampullaceus (Micrococcus), 252 amularium (Marmor), 1212 amygdalordes (Bacillus), 648 amylifera (Thiasphaerella), 998, 999 amyliferum (Spirillum), 217 amuloaceum var. auranticum (Propionibacterium), 379

amyloaerobius (Bacillus), 738 Amylobacter, 743, 748, 763 amulobacter (Bacillus), 771 amylobacter I (Bacillus), 771, 824 amylobacter II (Bacıllus), 771, 824 amylobacter III (Bacillus), 771, 824 amylobacter (Clostridium), 771 amylobacter (Metallacter), 771 amulobacter immobilia (Bacillus), 790, 826 amylobacter mobiles (Bacellus), 771 amylobacter S and W (Bacillus), 772, 824 amylocella (Vibrio), 203 amyloclasticus (Bacillus), 813 amuloclasticus intestinalis (Bacillus), 813 amylolacies (Streptococcus), 325 amylolyticus (Bacillus), 738 amylophilum (Pectinobacter), 823 amuloruber (Bacillus), 484 amyloruber (Erythrobacellus), 484 amylorubra (Serratia), 484 amylovora (Erwinia), 485, 1135 amylovorum (Achromobacler), 423 amylovorum (Bacterium), 465 amylovorum (Urobacterium), 423

amyloverus (Bacillus), 465 amylovorus (Micrococcus), 465 amylozyma (Bacillus), 771 amylozyme (Clostridium), 771 amylozymicus (Bacillus), 771 Anaerobacillus, 27, 763 Anaerobe No. III. Flügge, 813 Anaerobe No. IV, Flügge, 814 anaerobia (Gaffkya), 284 annerobic No. V (Bacillus), 818 anaerobic No. VIII (Bacıllus), 813 anaerobicum (Bacterium), 687, 819 anaerobicus (Bacillus), 820 anaerobicus alcaligenes (Bacillus), 801 anaerobicus caproicus (Bacillus), 820 anaerobicus liquefaciene (Bacillus), 819 anacrobicus magnus (Streptobacillus), 🖾 anaerobicus minutus (Bacillus), 368 annerobicus parvus (Coccobacillus), 368 anaerobicus tectus (Streptobacillus), 821 anacrobicus tenuis (Bacillus), 821 anaerobies (Actinomyces), 922 anaerobies (Oospora), 922 anaerobiontica (Pasteurella), 581 anaerobium (Achromobacter), 423 anaerobium (Bacterium), 673 anaerobium (Corynebacterium), 388, 402 anaerobius (Micrococcus), 247, 281 anaerobius (Staphylococcus), 247, 248 anaerobius (Streptococcus), 329, 345 anaerobius (Tetracoccus), 281 anaerobius cardu-s (Streptococcus), 323 anaerobius chromogenes (Bacıllus), 805 anaerobius diphtheroides (Bacillus), 40 anaerobius foetidus (Bacillus), 782 anaerobius gonoides (Streptococcus), 33 anaerobius gracilis (Racillus), 590 anaerobius kaemolysans (Bacillus), 20 anacrobius liquefaciens (Bacillus), 657, 819 anaerobius magnus (Bacillus), 823 anaerobius major (Staphylococcus), 281 anaerobius micros (Streptococcus), D. 330

330
anuerobius minor (Staphylaeoecus), S1
anaerobius perfortens (Coccobacillus), 516
anaerobius rectus (Bacillus), S2
anaerobius tenuis (Bacillus), S21

angerobius tenuis (Leptothrix), 365 anaerobius vulgaris (Streptocoecus). 328 angerobius typ. vulgaris (Streptococcus). anacrogenes (Bacillus), 533 angerogenes (Bacterium), 533 angerogenes (Escherichia), 533 Angeromyces, 925 ananas (Bacillus), 473 aganas (Bacterium), 127, 473 ananas (Erwinia) 127, 473 ananas (Phytomonas), 127 ananas (Pseudomonas), 127, 473 Anaplasma, 1100 anata (Escherichia), 523 anativestifer (Hemophilus), 554 anatipestifer (Pfeifferella), 554 anatus (Bacterium), 523, 552 anatia (Corunethriz), 406 anatia (Salmonella), 498,502, 523, 642 anatis (Spirochaeta), 1059 angtum (Bactersum), 523 anatum (Salmonella), 43, 523 anatum var. aertrucke (Salmonella), 502 anatum var, muenster (Salmonella), 523 analum var. nuborg (Salmonella), 523 ancens (Bacillus), 648 ancens (Leptotrichia), 367 ancens (Rasmussenia), 367 andoi (Vibrio), 201 andropogoni (Bacterium), 142 andropogons (Phytomonas), 142 andronogoni (Pseudomonas), 142, 169, 1136 anemocon (Microsporon), 918 anemones (Galla), 1158 anginosus (Strettococcus), 333, 331 Angiococcus, 1047 anglise (Marmor), 1200 anglomerans (Bacillus), 173 anguillarum (Bacillus), 673 anguitlarum (Bacterium), 673 anguillarum (l'ibrio), 203 angulans (Bacillus), 758

angulata (Phytomonas), 113

angulatum (Bacterium), 113

angulata (Pseudomonas), 113, 121

angulosum (Clostridium), 801, 827 angulosus (Bacillus), 801, 827 angulosus (Bacteroides), 801 angustum (Bacterium), 673 anhaemolyticus (Streptococcus), 337 anhaemolyticus vulgaris (Streptococcus), 337, 343 anindolica (Escherichia), 452 anindolicum (Bacillus), 452 anindolicum (Citrobacter), 448 annamensis (Cormebacterium), 403 annamensis (Salmonella), 530 annulare (Photobaeterium), 636 annularis (Microspira), 636 annulata (Pseudomonas), 173 annulata (Thiothrix), 990 annulates (Bacterium), 693 annulatum (Flavobacterium), 173 annulatus (Actinomyces), 968 annulatus (Actinomyces) (Streptothrix), 968 annulatus (Bacillus), 173, 648, 693 annulatus (Micrococcus), 252 annuliformans (Bacillus), 580 annuliformis (Bacillus), 738 Annulus, 1212 anodontae (Cristispira), 1055, 1056 anodontae (Spirochaeta), 1055 anolium (Serratia), 461 anazydana (Colloides), 595 anserina (Borrelia), 1058 anserina (Spirochaeta), 1058 anserina (Spironema), 1058 anserina (Spiroschaudinnia), 1058 anserina (Treponema), 1058 anzerinum (Spirillum), 1038 anserum (Spirillum), 1058 antaretica (Nitrosospira), 72 antenniforme (Flavobacterium), 440 antenniformis (Bacillus), 410 antenniformis (Bacterium), 440 anthraciformiz (Bacillus), 649 Anthracillus, 25, 27 anthracis (Aptanobacter), 719 anthracis (Bacillus), 719, 1138 anthracis (Racillus) (Bacteridium), 719 anthracis (Bacillus) (Streptobacter), 719

anthracis (Bacterium), 719 anthracis (Pollendera), 719 anthracis similis (Bacillus), 738 anthracis symptomatici (Bacillus), 776 anthracis-symptomatici (Clostridium), 776 anthracoides (Bacillus), 648, 716 anthracoides (Bacterium), 716 Anthrax, 20, 22 anthropopitheci (Spirochaela), 1079 antibioticus (Actinomyces), 942 antibioticus (Streptomyces), 942 antirrhini (Bacterium), 167 antirrhini (Phytomonas), 167 antirrhini (Pseudomonas), 167 antirrhini (Xanthomonas), 167 anularis (Cytaphaga), 1016 anularius (Bacillus), 648 Apelmocoena, 14, 1032 apertus (Annulus), 1214 aphrophilus (Hemophilus), 589 aphthicola (Streptococcus), 337 aphthosum (Bacterium), 673 aphthosus (Bacillus), 673 apiculatus (Chondromyces), 1038 apicum (Bacillus), 648, 738 apir (Bactersum), 639 apii (Phylomonas), 122 apri (Pseudomonas), 122 apiovorus (Bacillus), 470 apis No. 1, No. 2 and No. 3 (Bacterium), 673 apis (Streptococcus), 326, 724 apisepticus (Bacillus), 648 Aplanobacter, 8, 705 aporrhoeus (Bacillus), 738 appendicis (Actinamyces), 922 appendicis (Discomyces), 922 appendicis (Nocardia), 922 appendicitis (Bifidibacterium), 369 aptata (Phytomonas), 114 aptata (Pseudomonas), 43, 114 aptatum (Bacterium), 114 aquamarinus (Achromobacter), 419 aquatile (Flavobacterium), 428, 429 aquatile aurantiacum (Bacterium), 673 aquatile citreum (Bacterium), 673 aquatile debile (Bacterium), 673

aquatile flavum (Bacterium), 673 aquatile gasoformans non liquefacious (Bacterium), 657 aquatile luteum (Bacterium), 673 aquatile odorans (Bacterium), 491 aquatilis (Bacillus), 428, 648, 649 aquatilis (Bacterium), 428, 613 aquatilis (Diplococcus), 694 aquatilis (Micrococcus), 252, 695 aquatilis (Microspira), 199 aquatilis (Pseudomonas), 146 aquatilis (Streptococcus), 702 aquatilis (Streptothrix), 976 aquatilis (Vibrio), 199, 632 aquatilis (Zuberella), 577 aquatilis a (Bacillus), 684 aquatilis albissimus (Micrococcus), 695 aquatilis albus (Micrococcus), 252, 595 aquatilis communis (Bacillus), 619, 661, 699 aquatilis communis (Bacterium), 619 aquatilis flavus (Micrococcus), 252 aqualilis gasoformans non liquefacient (Bacillus), 657 aquatilis invisibilis (Micrococcus), 252 aquatilis magnus (Micrococcus), 695 aquatilis radiatus (Bacillus), 613 aquatilis radiatus (Bacterium), 613 aqualilis solidus (Bacillus), 659 aquatilis solidus (Bacterium), 658 aquatilis sulcatus (Bacillus), 655 aquatilis sulcatus I (Bacillus), 670 aquatilis sulcatus II (Bacellus), 670 aquatilis sulcatus III (Bacillus), 669 aquatilis sulcatus IV (Bacellus), 648 aquatilis sulcatus V (Bacillus), 655 aquatilis sulcatus quartus (Bacillus), 619 aquatilis sulcatus quartus (Baclerium), <sup>619</sup> aqualilis villosus (Bacillus), 671 aqueductum (Leptospira), 1078 aqueum (Bacterium), 759 aqueus (Micrococcus), 252 aquivirus (Micrococcus), 695 aquosus (Proactinomyces), 923 arabinosaceus (Betacoccus), 316 arabinosaceus (Leuconosloc), 316 arabinosum (Propionibacterium), 378

arabinosus (Lactobacillus), 357 arabinotarda Tupes A and B (Shigella). 514 arachidis (Marmor), 1187 arachnoidea (Beggiatoa), 922, 993 arachnoidea (Oscillaria), 992 arachnoideus (Bacillus), 738 argliavora (Erwinia), 477 araliavorus (Bacıllus), 477 arborescens (Actinomyees), 919 arborescens (Bacillus), 435, 436, 649, 919 arborescens (Bacterium), 435 arborescens (Erythrobacillus), 435 arborescens (Flavohacterium), 429, 435, 439 arboreseens (Nocardia), 919 arborescens lactis (Micrococcus), 252 arboreseens non-liquefaciens (Bacillus), arborescens non-liquefaciens (Bacterium), 436, 673 arboreus (Bacillus). 613 Archangium, 1017 archeri (Gaffkya), 284 archibaldli (Salmonella), 531 arcticum (Achromobacter), 423 grelieum (Bacterlum), 673 arechavaleta (Salmonella), 506 arenarius (Bacillus), 728 argenteo-phosphorescens (Bacillus), 631 argenteo-phosphorescens I (Bacillus), 634 argenico-phosphorescens II (Bacillus), 634 argenteo-phosphorescens III (Bacillus), 631 argenteo-phosphorescens (Bacterium), 631 argenteo-phosphorescens lique aciens (Bacillus), 631 argenteus (Micrococcus), 252 argentinensis (Spirochaeta), 1065 argentinensis (Treponema), 1065 argentophosphorescens (Achromobacter). 631 arquata (Cellulomonas), 176 arguta (l'scudomonas), 176 aridus (Bacillus), 738 arizona (Salmonella), 462

Arloingillus, 11, 763

arlonoii (Bacillus), 738

armorocise (Bacillus), 710 araideae (Bacillus). 474 aroideae (Bacterium), 474 argideae (Erwinia), 470, 474, 1129, 1136 aroideae (Pectobacterium), 474 aromafaciens (Achromobacter), 423 aromafaciens (Bacterium), 423 aromalica (Pseudomonas), 146 aromatica var. quercitopurogallica (Pseudomonas), 146 aromaticum (Flavobacterium), 457 aramaticus (Bacillus), 431, 457, 649, 743 aramaticus (Baclersum), 457 aromaticus (Streptoegecus), 337 aromaticus buturi (Bacillus), 440 aromaticus lactis (Bacillus), 434 arthritica (Micrococcus), 301 arthritica (Neisscria), 301 arthritidis (Bacterium), 674 arthritidis (Murimyces), 1292 arthritidis chronicae (Bacillus), 671 arthritidis-muris (Corynebaeterium), 402 Arthrobacter, 7 Arthrobactridium. 7 Arthrobactrillium, 7, 82 Arthrobactrinium, 7, 82 Arthromitus, 1003 Arthrostreptokokkus, 312 arthrotropicus (Museulomyces), 1213 arthurs (Bacillus), 639 articulața (Pseudomonas), 146 articulatum (Bacterium), 759 articulorum (Streptococcus), 337 artus (Phagus), 1133 arcalis (Grahamella), 1109 arcicolas (Bartonella), 1101 arricolae (Hoemobarionella), 1101 arvilla (Pseudomonas), 105 arrillum (Ackromobacter), 105 asaccharolyticus (Micrococcus), 248 asaccharolyticus (Staphylococcus), 216 asarcharolyticus var. indolicus (Stanhulo. coccus), 217, 261 asalignus (Streptococcus), 337 ascendens (Acetobacter), 43, 185, 692 ascendent (Baclerium), 185 ateen lens (Ulrina), 602

ascitis (Corynebacterium), 402 Ascococcus, 6, 235 ascoformans (Botryocaccus), 253 ascoformans (Micrococcus), 252, 253 ascoformans (Staphylococcus), 253 ascoformis (Micrococcus), 253 asiaticum (Bactersum), 450 asiaticus (Bacillus), 450, 738 asiaticus (Proteus), 450 asiaticus (Salmonella), 450 assalicus mobilis (Bacıllus), 450 asiaticus mobilis (Salmonella), 450 asparagi (Bacıllus), 759 asparagi (Bacterium), 759 asper (Micrococcus), 253 asplenii (Phytomonas), 696 asporiferum (Bacterium), 674 assimilis (Bacillus), 649 assurgens (Archangium), 1019 Astasia, 20, 22, 705 asteracearum (Bacillus), 477 asteracearum (Erwinia), 477 asteriformis (Bacillus), 612 asteris (Bacillus), 738 Asterococcus, 1239, 1291 asteroide (Leptothrix), 218, 365 asteroide (Mycobacterium), 896 Asteroides, 892 asteroides (Actinomyces), 896 asteroides (Asteroides), 896 asteroides (Cladothrix), 896 asteroides (Discomyces), 896 asteroides (Nocardia), 895, 897, 918 asteroides (Oospora), 896 asteroides (Proactinomyces), 896 asteroides (Streptotrix), 896 asteroides var crateriformis (Nocardia). 897 asteroides var cratersformis (Proactinomyces), 897 asteroides var. decolor (Nocardia), 897 asteroides var decolor (Proactinomyces), usteroides var. gypsoides (Nocardia), 897 gypsoides (Proactinoasteroides var myces), 897

asteroides vat. serratus (Actinomyces), 917 . Asteromyces, 1291 asterospora (Astasia), 720 asterosporus (Aerobacillus), 720 asterosporus (Bacillus), 720, 748 asterosporus alpha (Bacıllus), 720 astheniae (Bacillus), 448 astheniae (Bacterium), 448 astheniae (Escherichia), 443 asthenoalgiae (Leptospira), 1078 asthenogenes (Bacillus), 738 astragalí (Bacterium), 139 astragali (Phytomonas), 133 astragali (Pseudomonas), 139 astri (Marmor), 1196 astrictum (Marmor), 1165, 1167 astrictum var. aucuba (Marmor), 1168 astrictum var. chlorogenus (Marmor), 1183 astrictus (Phagus), 1133 aterrimus (Bacillus), 711 aterrimus techitensis (Bacıllus), 738 atherton (Salmonella), 701 atlantica (Pseudomonas), 697 Atremia, 13 atrofaciens (Bacterium), 120 atrofaciens (Phytomonas), 121 atrofaciens (Pseudomonas), 120 atroseptica (Erwinia), 468, 470, 1184 atrosepticus (Bacillus), 468, 470 attenuatum (Spirillum), 43, 217 attenuatum (Spirosoma), 217 atypica pseudotuberkulosa (Actinomyces), 973 aucuba (Marmor), 1175 aucuba var. canadense (Marmor), 1175 aucubicola (Pseudomonas), 146 aurantia (Spirochaeta), 1053 aurantiaca (Cladothrix), 896 aurantiaca (Cytophaga), 1013 aurantiaca (Merismopedia), 251, 200 aurantiaca (Nocardio), 896 aurantiaca (Oospora), 896 aurantiaca (Paulosarcina), 288 aurantiaca (Sarcina), 243, 288 aurantiava (Stigmatella), 1037 qurantiaca (Streptothrix), 896

Rods: 1 by 2 microns, sometimes slightly curved, filaments present. Motile with polar flagellum Gramnegative.

Green fluorescent pigment produced

in culture.

Celatin stab: Slow liquefaction.

Beef extract agar Whitish, circular

colonies, 2 mm. in diameter Edges entire.

Broth: Turbid.

Milk: Alkaline.

Nitrites not produced from nitrates.

Indole not formed.

Hydrogen sulfide not formed

Not lipolytic (Starr and Burkholder, Photopath, \$2, 1942, 601).

Adid but no gas from glucose, fructose, mannose, arabinose, xylose, sucrose and glycerol. No acid from rhamnose, lactose, maltose, manutol and salicin Alkah from salts of citric and maile acids, but not from acetic, formic, lactic or tartario acids. Starch and cellulose not bydrolyzed.

blight growth in broth plus 4 per cent

salt.

Optimum temperature 20° to 23°C. Maximum 33°C. Minimum 25°C. (Hedges, loc cit.).

Optimum pH 6.7 to 7.3. Maximum 88 to 9.2. Minimum 50 to 53. (Kotte, Phyt. Zeltsch, 2, 1930, 453.)

Microacrophilic

Source: Isolated from leaves, pod and stem of beans showing halo blight.

Habitat: Pathogenic on beans (Phascolus vulgaris), the kudzu vine (Pueraria hirsuta) and related plants

50. Pseudomonas pisi Sackett. (Sackett, Colorado Agr. Evp. Sta., Bull 218, 1918, 19, Bacterium pris Erw. Smith, An Introduction to Bacterial Discares of Plants, 1920, 474; Phydomona pris Hergey et al., Manual, 1st ed., 1923, 181.) From Gr. pisum, the pea; M.L. Pisum, a generic name.

Rods: 0.68 to 226 microns. Motile with a polar flagellum, Gram-negative.

Green fluorescent pigment produced in culture.

Gelatin: Liquefaction.

Agar slants: Moderate growth in 24 hours, filiform, glistening, grayish-white. Broth: Turbid with a scum in 5 days.

Milk: Alkaline, soft curd, clears Nitrites not produced from nitrates

Nitrites not produced from nitrates.

Indole pot produced.

No II2S produced.

Not hipolytic (Starr and Burkholder, Phytopath., 52, 1942, 601).

Acid but notgas from glucose, galactose and sucrose.

Starch not hydrolyzed.

Optimum temperature 27° to 28°C Maximum 37.5°C. Minimum 7°C.

Acrobic.

Source Ten cultures isolated from 5 collections of discased peas showing water soaked lesions on stems and petioles.

Habitat: Pathogenic on gardon peas, Pisum satirum and field peas, P. satirum var arrense.

81. Pseudomonas syringae van Hall. (Kennis der Bakter. Pflanzenziekte, Inaug Diss., Amsterdam, 1902, 191; Bacterium syringae Erw. Smith, Baateria in Relation to Plant Diseases, 1, 1905, 63; Phylomonas syringae Bergey et al., Manual, 3rd ed., 1930, 257) From Latin, syringa, a nymph that was changed into a reed; M.L. Syringa, a generic name

Synonyms Bryan (Jour. Agr. Res., 36, 1935, 225) lasts Bacterium etriputeale C. O. Smith, Phytopath., 5, 1913, 69, and Bacterium citrarefaciens Loc, Jour. Agr. Res., 9, 1917, 1 (Pseudomoras citrarefacers Stapp, in Sorauer, Ilandb d. Pflancenkranheiter, 2, 5 Aufl, 1923, 190). Clara (Cornell Agr. Exp. Sta.

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avium (Bacıllus), 400 avium (Bacterium), 674 avium (Borreliota), 1229 avium (Mycobacterium), 878, 879, 880 nvium (Pasteur, lla), 547 avium (Rickettsia), 1095 avium (Strongyloplasma), 1229 avium (Tarpeia), 1274 azolicus (Bacillus), 772, 824 Azotobacter, 19, 21, 26, 29, 31, 216, 219, 221

azotobacter (Bacillus), 219 azotogena (Pseudomonas), 697 Azotomonas, 8, 219, 221 azurcus (Bacıllus), 649

babesi (Bacıllus), 649

babesi (Neisseria), 254, 696 Babesta, 312 babezu (Bacterium), 674 baccarınıi (Bacıllus), 466 baccarınıi (Closiridium), 478 baccatus (Micrococcus) (Sarcina), 253 bacıllıfera (Pelogloca), 871 bacilliformis (Bartonella), 1101, 1105 bacıllıformıs (Bartonia), 1101 bacıllosum (Amoebobacter), 849 Bacillus, 6, 7, 13, 15, 18, 19, 22, 27, 39, 31, 42, 43, 46, 63, 76, 179, 632, 643, 704, 705, 763, 1008 Bacillus I, Bienstock, 755 Bacillus II, Bienstock, 753 Bacillus II, Leube, 668 Bacillus a, Guillebeau, 662 Bacillus a, b, c, d, e, f, h and i, Vignal, 647

Bacillus A, Grigoroff, 354 Bacillus A. Maggiora, 671 Bacillus B. Hoffmann, 749 Bacillus B, Maggiora, 661

Bacillus D, Foutin, 744 Bacıllus D, Peters, 741

Bact lus G, Maggiora, 650 Bacıllus H, Maggiora, 662

Bacillus X, Moore and White, 726 Bacillus a, Busse, 639

Bacillus a, von Freudenreich, 356

Bacillus y, von Freudenreich, 358

Bacillus 5, von Freudenreich, 360 Bacillus e, von Freudenreich, 352 Bacillus No. 18, Conn. 760 Bacillus No. 25, Conn, 753 Bacillus No. 41, Conn. 423

Bacillus No. 2, Fulles, 668 Bacillus No. 2, Kedrowski, 814 Bacillus No. 3, Pansini, 718

Bacillus No. 6, Pansini, 710 Bacillus No. 8, Pansini, 738

Bacillus No. XVI, Adametz, 718 Bacillus No. XVII, Adametz, 760 Bacillus No. 1, Flügge, 716, 725 Bacillus No. II, Flügge, 741

Bacillus No. III, Flügge, 738 Bacillus No. IV, Flugge, 744 Baci lus No. V, Flügge, 716 Bacillus No. VI, Flugge, 743

Bacillus No. VII, Flugge, 747 Bacıllus No. VIII, Flügge, 748 Bacillus No. IX, Flugge, 7.0

Bacillus No. X, Flugge, 709 Bacıllus No. XI, Flügge, 743 Bacillus No. XII, Flugge, 755, 761 Bacillus of swine plague, 508

Bacillus sp., Sordelli, 777 Bacteridium, 6, 43, 705 Bacterienart No. 13, Lembke, 745 bacterifera (Cylindrogloga), 874

Bacteriophagum, 1128, 1129 bacteriophagus (Protobios), 1129

Bacteriopsis, 179, 365 Bacterium, 5, 7, 10, 13, 15, 17, 18, 19, 28, 30, 37, 42, 46, 76, 82, 179, 435, 596, 597,

599, 612, 694, 705, 783 Bacterium A, Peters, 657 Bacterium B, Peters, 664 Bacterium of hog cholera, 508 Bacterium of swine plague, 508

Bacteroidea, 20 Barteroides, 22, 23, 27, 31, 32, 218, 365,

**564,** 763, 1296 Bactoderma, 76

Bactrella, 705 Bactridium, 7, 705, 763

Bactrillius, 83 Bactrillum, 7, 13, 25, 27, 82, 705

```
aurantiacum (Agarbacterium), 630
aurantiacum (Bacteridium), 243
aurantiacum (Chromobacterium), 440
aurantiacum (Cornnebacterium), 402, 404
aurantiacum (Flavobacterium), 440
aurantiacum (Polycephalum), 1037
aurantiacus (Actinomyces), 896
aurantiacus (Aurococcus), 243
aurantiacus (Bacillus), 440
aurantiaçus (Bacterium), 440
aurantiacus (Chondromyces), 1037, 1038
aurantiacus (Micrococcus), 243, 265, 275,
  290
 aurantiacus (Pediococcus), 243, 290
 aurantiacus (Staphylococcus), 243
 aurantiacus (Streptococcus), 243, 253, 337
 aurantiacus-sorghi (Micrococcus), 243, 253
 aurantiacus tingitanus (Bacıllus), 145.
 aurantiacus var. frutescens (Chondro-
   myces), 1037, 1039
 aurantibuturicum (Clostridium), 819
 aurantii (Bacillus), 674
 aurantis (Bacterium), 671
 aurantinum (Flaiobacterium), 410
 aurantinus (Bacillus), 440
 aurantium (Plocamobacterium), 674
 aurantium roseum (Bacterium), 392, 674
 aurantius (Bacillus), 619, 738, 739
  aurantius (Cellulomonas), 739
  aurea (Aclinomuces), 913, 969
  aurea (Nocardia), 968
  aurea (Oospora), 969
  aurea (Pscudomonas), 146, 697
  aurea (Sarcina), 200
  aurea (Streptothrix), 968
  aureo-flavus (Bacillus), 674
  aureo flarus (Bacterium), 674
  Aureogenus, 1154
  aurescens (Bacillus), 410, 474, 674
  aurescens (Bacterium), 140, 415, 481, 674
  aurescens (Flavolneterrum), 410
  aurescent (Sarcina), 200
   aurescens vat mucosa (Sarcina), 200
  aureum (Bacterium), 674
   aureum (Polyangium), 1031
   aureum (Spirillum), 203
```

aureum (Spirosoma), 203 aureus (Actinomyces), 943, 968, 977 aureus (Auracoccus), 211 aureus (Bac:llus), 649, 674, 716 aureus (Flexibacter), 38 aureus (Micrococcus), 241, 251, 252, 253, 254, 256, 258, 265, 266, 268, 269, 271, 276, 279 aureus (Muxobacter), 1026 aureus (Staphylococcus), 241, 1140, 1141 aureus (Streptomyces), 943 aureus (Vibrio), 203, 204 aureus var. equi (Staphylococcus), 253 aureus lactis (Micrococcus), 253 aureus minutissimus (Bacillus), 663 aureus sarciniformis (Staphylococcus), 281 auris (Bacillus), 402 auris (Corynebacterium), 402 Aurococcus, 8, 235 aurogenes (Bacillus), 617 aurogenes (Cellulomonas), 617, 622 aurogenes var. albus (Bacillus), 622 australiense (Lethum), 1223 australiense var. lcthale (Lethum), 1224 australiense var. typicum (Lethum), 1224 australiensis (Chlorogenus), 1147 autumnalis (Leptospira), 1078 autumnalis (Spirochaeta), 1078 autumnalis A (Spirochaeta), 1078 aulumnalis Type B (Leplospira), 1077, auxinophilum (Bacterium), 145 andt (Achnomyces), 915, 921 aicnae (Bacillus), 116 avenae (Fractilinea), 1162 arenae (Phytomonas), 116 arenae (l'scudomonns), 116 avicida (l'asteurella), 547, 552, 642 aricidum (Bacterium), 546, 547 aricidus Coccobacillus), 547 avidum (Corynelneterium), 388, 4°2 avidus (Bacteroides), 180, 402

andus (Vibrio), 702

ariseptica (Pasteurella), 523, 517

acisepticum (Bacterium), 517

acisepticus (Bacillus), 530, 547

bellus (Bacillus), 739 belorinensis (Bacillus), 360 bemisiae (Ruga), 1219 bentolensis (Bacillus), 533 bentotensis (Bacterium), 533 bentotensis (Castellanus), 533 bentotensis (Eberthella), 533 benzali (Bacillus), 649 benzoli a and b (Bacterium), 674 berardinisi (Discompces), 918 berardinisi (Nocardia), 918 berbera (Borrelia), 1061 berbera (Spirochaeta), 1061 berbera (Spironema), 1061 berbera (Spiroschaudinnia), 1061 berberidis (Bacterium), 115 berberidis (Phytomonas), 115 berberidis (Pseudomonas), 115 berberum (Treponema), 1961 berestneffi (Nocardia), 919 berestneffir (Actinomyces, 919 berestneffit (Discomuces), 919 beresinewi (Bacillus), 918 bergerac (Annulus), 1213, 1216 beri-beri (Micrococcus), 253 beribericus (Bacillus), 649 bernardinisi (Actinomyces), 918 bernensis (Bacillus), 739 berolinensis (Bacillus), 234, 360, 650 berolinensis (Lactobacillus), 360 berolinensis (Microspira), 196 berolinensis (Mycobacterium), 888, 890 berolinensis (Pseudomonas), 697, 698 berolinensis (Vibrio), 196, 204 fasciformis (Saccharoberolinensis bacillus), 360 berolinensis indicus (Bacillus), 697 berolinensis indicus (Bacterium), 697 berta (Salmonella), 518 bertherandi (Consothecrum), 289 bessers (Bacterium), 674 besson: (Kurthia), 613 beta (Bacillus), 650, 739 beta (Micrococcus), 269 beta (Nocardia), 976 beta (Phagus), 1141

beta (Scelus), 1237

bela (Streptothrix), 976 beta (Tarpeia), 1270 Betabacterium, 9, 30, 350 Betacoccus 9, 30, 346 betadelbruecksi (Lactobacsllus), 363 belae (Bacillus), 477, 639 betae (Bacterium), 144, 639 betae (Butylobacter), 781, 825 betae (Corium), 1204 betae (Marmor), 1178 belas (Myxobacillus), 762 belae (Myzococcus), 348 betae (Phytomonas), 141 betae (Savoia), 1221 belae viscosum (Bacterium), 674 betainovorus (Bacillus), 739 betanigrificans (Bacillus), 739 beticola (Bacillus), 478 beticola (Bacterium), 478 beticola (Phytomonas), 153 beticola (Pseudomonas), 153, 1134 beticola (Xanthomonas), 153, 230 beticolum (Bacterium), 153 betivera (Erwinia), 468 betwerus (Bacillus), 468 betle (Aplanobacter), 130 betle (Bacterium), 130 letlis (Phytomonas), 130 betlis (Pseudomonas), 130 biaculum (Bacıllus), 739 biacutum (Fusobacterium), 582 biacutus (Fusiformis), 582 biazotea (Cellulomonas), 617 biazoteus (Bacillus). 617 bibula (Cellulommes), 615 bibulum (Bacterium), 615 bibulus (Bacillus), 615 bicolor (Actinomyces), 919 bicolor (Micrococcus), 254 bicolor (Nocardia), 919 bicolor (Sarcina), 200 bienstocki (Putrificus), 799 bienstockii (Bacillus), 541 bienstockii (Baclerium), 544 bienstockii (Eberthella), 544 bienstockii (Shigella), 514 bifermentans (Bacillus), 787

Bactrinium, 7, 82, 705 Bactrinius, 83 badius (Bacillus), 739 badius (Microcoecus), 253 bahiensis (Actinomyces), 919 bahiensis (Discomyces), 019 bahiensis (Nocardia), 919 bahiensis (Oospora), 919 balaenae (Clostridium), 775, 819 balanitidis (Spiroehaeta), 1065 balanıtidis (Spironema), 1065 balanitidis (Spiroschaudinnia), 1065 balanılıdis (Treponema), 1065 balbianii (Bacillus), 674 balbianii (Bacterium), 674 balbianii (Cristispira), 1055, 1056, 1057 balbianii (Spirochaeta), 1055 balbianii (Trypanosoma), 1055 balcanus (Bacillus), 730 balfourii (Grahamella), 1109 Balkanella, 10 ballerup (Salmonella), 520 baltieum (Photobacterium), 635, 636 ballieus (1 ibrio), 636 balustinum (Flavobacterium), 437 bamplonis (Chromobacterium), 231 bantam (Salmonella), 523 barati (Inflabilie), 823 barbareae (Phytomonas), 151 barbareae (Xanthomonas), 154 barbatum (Hacterium), 761 barbitistes (Bacıllus), 739 baregensis purpureus (Micrococcus), 253 bareitly (Solmonella), 511 bareitly var mikawasima (Salmonella), barentsianum (Bacterium), 674 barkeri (Bacillus), 129 barkeri (Bacterium), 129 barkeri (Phytomonas), 129 barkeri (Pseudomonus), 127, 134 Bartonella, 37, 1100, 1102, 1109 Bartonella sp., 1108 Bartonia, 1100 batatae (Bacıllus), 734 bataria (Salmonella), 524

batariae (Leptospira), 1875

batrachorum (Arthromitus), 1003 balrachorum (Bartonella), 1108 batrachorum (Haemobartonella), 1108 batrochorum (Micrococcus), 1123 bauri (Bacterium), 108 beaufortensis (Pseudomonas), 697 beckse (Bacterium), 552 beddardii (Actinomyces), 963 beddardii (Streptomyces), 963 Beggiatoa, 12, 16, 18, 19, 24, 26, 42, 988, 990, 993, 994, 1007 beggiatoides (Oscillatoria), 992 begonsae (Bacterium), 155 begoniae (Phytomonas), 155 begoniae (Xanthomonas), 155 beigeliana (Zoogloea), 253 beigelianum (Sclerotium), 253 beigells (Chlamydatomus), 253 bergelri (Hyalococcus), 233 beigelii (Micrococeus), 233 bergelii (Pleurococcus), 253 beigelis (Trichosporum), 253 beijerineki (Bacillus), 356, 650, 691 beijerineki (Baeterium), 674 beijerinchii (Azotobacter), 219 beijerinckii (Clostridium), 772 beijerineksi (Laetobacıllus), 357 beijerinckii (Pseudomonas), 109 berjerinekii (Rhisobrum), 225 beijersnekii (Rhisomonas), 223 beigerincksi (Sareina), 286 beijerinckei (Thiobactereum), 81 bergerinekss (Urobacillus), 691 bcijerinckii (Vibrio), 203 beijerinek ir var. jacobsenii (Thiobacterium), 81 belkerii (Mycobacterium), 890 belfanti (Bacetlus), 649, 803 belfantii (Clostridium), 803 belfantii (Endosporus), 649, 803 belfastiensis II (Racillus), 533 belfastiensis V (Bacıllus), 531 belfastiensis (Racterium), 533

belfastiensis (Eberthella), 533

bellonensis (Bacitlus), 777, 825

bellanensis (Clostridium), 779

bellisari (Actinomyces), 968

boreale (Flavobacterium), 625 bereopolis (Pseudomonas), 94 boreus (Micrococcus), 254 bornensis (Erro), 1256 Borrelia, 19, 34, 35, 37, 42, 1057, 1058 Borrelina, 1225 Borreliota, 1229 Borrelomyces, 1291 borstelensis (Bacıllus), 739 bosporum (Bacterium), 145 bossonis (Bacterium), 675 bostroemi (Actinomyces), 970 botkini (Bacıllus), 813 botryogenus (Micrococcus), 253 Botryomyces, 235 Botulenea, 20 botulinum (Clostridium), 778, 784 botulinum D (Bacillus) (Clostridium), 779 bolulinum Type A (Clostridium), 784 botulinum Type B (Clostridium), 784 botulinum Type C (Clostridium), 779 botulinum Type D (Clostridium), 779 botulinum Type E (Clostridium), 779 Botulinus, 20, 22, 763 botulinus (Bacillus), 778 botulinus (Ermengemillus), 778 botulinus Type C (Bacillus), 779 Botulobacillus, 8, 763 bouffordi (Pasteurella), 553 boutrouxii (Bacillus), 675 boutrouxii (Bacterium), 675 bovicida (Bacterium), 548 boridae (Treponema), 1076 Bovimyces, 1291 bovina (Listerella), 409 bovinum (Scelus), 1239 bovinus (Micrococcus), 254, 337 bovinus (Streptococcus), 337 bovis (Actinomyces), 925, 926, 927 boris (Bacillus), 652 bovis (Bacterium) 675 bovis (Bartonella), 1106 bovis (Betacoccus), 347 bovis (Cladothrix), 925 bovis (Corynebacterium), 390, 391 bovis (Corynethrix), 401 boris (Discomyces), 925

bovis (Ehrlichia), 1095 bovis (Grahamella), 1110 bovis (Haematococcus), 254 bovis (Haemobartonella), 1106 bovis (Hemophilus), 591 bovis (Leptospira), 1078 bovis (Leuconostoc), 347 boris (Micrococcus), 254 bovis (Molitor), 1242 bovis (Morasella), 591 bovis (Nocardia), 925 boris (Oospora), 925 bovis (Proactinomyces), 925 bonis (Rickettsia), 1095 bavis (Sphaeratilis), 925 boris (Staphylococcus), 264, 281 bovis (Streptococcus), 320, 521, 322 bovis (Streptothrix), 925 bovis (Tortor), 1276 bovis var. nigerianus (Actinomyces), 968 bovis albus (Actinomyces), 968 ~ 1 'r" 1 - 1 - 3 - 1 1085

bovis farcinicus (Actinomyces), 895 boris luleoroseus (Actinomyces), 971 borıs morbificans (Bacillus), 514 bovis morbificans (Salmonella), 514 bovis sulfureus (Actinomyces), 925 boviseptica (Pasteurella), 547 borrsepticus (Bacillus), 547 borisepticus (Bacterium), 547 bovium (Pasteurella), 547 bowlesiae (Pseudomonas), 125 boulesii (Bacterium), 125 bowlesii (Phytomonas), 125 Brachybacterium, 312, 349 brachysporum (Bacterium), 759 brachythrix (Bacillus), 650 braenderup (Salmonella), 511 brandenburg (Salmonella), 505 brandenburgensis (Salmonella), 505 brandenburgiensis (Bacillus), 726 brandti (Bacterium), 108 brankamii (Micrococcus), 303 brasiliensis (Actinomyces), 918 brasiliensis (Discomyces), 918

bifermentans (Clostridium), 309, 782, 787, 818, 825 bifermentans (Martellillus), 787 bifermentans sporogenes (Bacillus), 787 bifida (Lieskeella), 986 bifida (Nocardia), 353 Bifidibacterium, 31, 38, 369 Bifidobacterium, 349, 359 bifidum (Bacterium), 354 bifidum (Bifidibacterium), 353, 369 bifidus (Actinomuces), 353 bifidus (Bacillus), 353 bifidus (Bacteroides), 353, 354 bifidus (Cohnistreptothrix), 353 bifidus (Lactobacillus), 353, 334, 369 bifidus II (Lactobacıllus), 351 bifidus aerobius (Bacillus), 361 bifidus capitatus (Bacillus), 361 bifidus communis (Bacillus), 353, 361 bifilarıs (Lieskcella), 986 bifleya (Leptospira), 1077, 1078 biflexa (Spirochaeta), 1077 bisorme (Eubacterium), 369 biformis (Bacteroides), 362, 363 hifurcalum (Bifidibacterium), 369 bifurcalus gazogenes (Bacillus), 369 biliohemoglobinuriae (Leptospisa), 1078 bilio-hemoglobinuriae (Spirochaeta), 1078 Billetia, 680 billings: (flacillus), 650 billrothii (Ascococcus), 251 billrothis (Micrococcus), 251 binucleatum (Bacterium), 760 bipolare multoculum (Bacterium), 517 hipolaris (Bacillus), 519, 718 bipolaris bovisepticus (Bacillus), 547 bipolaris bubalisepticus (Bacillus), 518 bipolaris caprisepticus (Hacillus), 553 bipolaris orixepticus (Bacillus), 551 bipolaris plurisepticus (Bacillus), 516 bipolaris repticus (Bacillus), 516, 517 binunctata (Macronionas), 937, 1001 bipunctata (Pseudomonas), 997, 1001 bipunctata (Thiospira), 212 bipunctatum (Spirillum), 212 biskin (Wicroenceus), 251 histrae (Staphulwoveus), 251

bispebterg (Salmonella), 506 bizzozerianus (Bicillus), 743 blackuellu (Actinomyces), 910 blackwellis (Nocardia), 910 blance (Reckettsiu). 1088 blarinae (Grahamella), 1110 blaringe (Harmobartonella), 1107 blasticus (Chondrococcus), 1008, 1046 Blastocaulis, 35, 836 blattellae (Corynebacterium), 402 blegdam (Salmonella), 518 bleischn (Bacillus), 533 boas-opplers (Lactobacellus), 352 bobiliae (Actinomyces), 937 bobiliae (Streptomyces), 937 boleti (Micrococcus), 254 boletus (Melittangium), 1006, 1034 bollingeri (Pasteurella), 547 bolognesis-chiurcos (Actinomyces), 915 bolognesis-chrurcoi (Malbrachea), 915 bombucis (Aerobacter), 400 bombyers (Bacillus), 650, 739 bombycis (Bacterium), 650 hombycia (Borrelina), 1223 bomburis (Chalmydozoon), 1226 bombycis (Diplococcus), 336 bombyers (Micrococcus), 251 bombycis (Microsyma), 251 bombyets (Nosema), 254 bombyets (Proteus), 490 bombyers (Streptococcus), 254, 265, 337 bombucis non-liquefaciens (Bacillus), 739 bombycivorum (Bacterium), 490 bombycoides (Bacillus), 739 bombyscpticus (Bacillus), 739 bonariensis (Leptospira), 1078 bonariensis (Salmonella), 514 bonhoffii (Hicrospira), 202 bonricini (Streptococcus), 337 bookeri (Alcaligenes), 415, 416 bookers (Bacillus), 115, 650 booken (Racterium), 415 borbeck (Salmonella), 527 borborokoites (Bacillus), 739 bordonii (Bocterium), 1911 bordonii (Klebsiella), 691 boreale (Bacterium), 625

buccalis (Microspira), 1062 buccalis (Molitor), 1242 buccalis (Nocardia), 922 buccalis (Oospora), 922 buccalis (Rasmussenia), 365 buccalis (Spirochaeta), 1062, 1065 buccalis (Spiroschaudinnia), 1062 buccalis (Streptococcus), 338 buccalis (Streptothrix), 923 buccalis (Syncrotis), 365 buccalis (Vibrio), 203 buccalis fortuitus (Bacillus), 617, 650 buccalis fortuitus (Bacterium), 650 buccalis minutus (Bacillus), 440 buccalis minutus (Bacterium), 440 buccalis muciferens (Bacillus), 650 buccalis septicus (Bacillus), 650 bucco-pharynger (Spirochaeta), 1065 bucco-pharynge: (Treponema), 1065 buchners (Bacellus), 359 buchneri (Lactobacillus), 359, 695 buchners (Ulvina), 695 buda pest (Salmonella), 505 budayı (Bacıllus), 791 bufo (Agarbacterium), 628 bufonis (Spirochaeta), 1066 bufonis (Spironema), 1066 bufonis (Spiroschaudinnia), 1066 bufanis (Treponema), 1006 bulbosa (Vibrio), 203 bulgaricum (Acidobacterium), 354 bulgaricum (Bacterium), 354, 687, 695 bulgaricum (Plocamobacterium), 354 bulgaricum (Thermobacterium), 354 bulgaricus (Bacillus), 354 bulgaricus (Lactobacıllus), 354, 362, 364, 695 bullata (Mycoplana), 191

bullosum (Bacterum), 675
bullosus (Bacterum), 675
bullosus (Bacteroides), 580
bullosus (Bacteroides), 580
bullosus (Spherocitlus), 580
burchardts (Micrococcus), 254
burger (Bactellus), 116
burnet (Rickettsia), 1092
burnet var americana (Rickettsia), 1092
burnet var americana (Rickettsia), 1092
burnet var americana (Rickettsia), 1092

burnetii (Coxiella), 1000, 1092 burri (Bacillus), 726 buzac assaticae (Bacterium), 357 busacastaticus (Lactobacillus), 357 bussei (Bacillus), 477 bussei (Erwinia), 477 butantan (Salmonella), 524 butlerovii (Bacillus), 740 būtschlii (Bacıllus), 740, 742, 744 butylaceticum (Bacıllus), 781, 825 Butylbacillus, 771 butylicum (Amylobacter), 771, 813 butylicum (Clostridium), 771 butylicum (Granulobacter), 771, 824 butylicus (Bacillus), 680, 771, 824 butylscus B. F. (Bacillus), 781, 825 Butylobacter, 763 butyri (Achromobacter), 421 Butyribacillus, 8, 763 butyri (Bacillus), 650 butyri I (Bacillus), 650 butyr: II (Bacillus), 659 Butyribacterium, 368, 380, 402 butyr: (Diplococcus), 254 butyri (Flavobacterium), 440 butyri (Mycobacterium), 890 butyra (Micrococcus), 254 butyri (Pseudomonas), 146, 697 butyri aromafaciens (Bacillus), 421 butyriaromafaciens (Bacterium), 421 bulyri-aromafaciens (Micrococcus), 471 butyre colloideum (Bacterium), 676 butyr: fluorescens (Bacillus), 146 butyrı fluorescens (Bacterium), 697 butyre fluorescens (Micrococcus), 254 butyrica (Botulinea), 22 butyrica (Sarcina), 290 Butyriclostridium, 11, 763 butyricum (Bactridium), 771, 819, 821 butyricum (Clostridium), 716, 770, 771. 772, 781, 813, 824, 825 butyricum (Mycobacterium), 888, 890 butyricum I (Clostridium), 771 butyrıcum II (Clostridium), 771 bulyricum III (Clostridium), 771 butyricum iodophilum (Clostridium), 772

brasiliensis (Escherichia), 452 brasiliensis (Nocardia), 918 brasiliensis (Oospora), 918 brasiliensis (Rickettsia), 1087 brasiliensis (Streptothrix), 918 brassicae (Bacillus), 675, 714, 718 brassicae (Bactersum), 357, 675, 714, 718 brassicae (Borrelina), 1227 brassicae (Lactobacıllus), 357 brassicae (Marmor), 1177 brassicae acidae (Bacterium), 146, 675 brassicae acidae (Pseudomonas), 146 brassicae fermentatae (Bacillus), 358 brassicaevorus (Bacıllus), 477 bredemannii (Bacıllus), 739 bredeney (Salmonella), 507 breilfussi (Bactersum), 675 breslau (Salmonella), 502 breslaviensis (Bacillus), 502 breslaviensis (Bacterium), 502 breve (Baeterium), 439 brere (Betabacierium), 358 breve (Flavobacterium), 439 brevis (Bacillus), 439, 725, 739, 744 brevis (Lactobacillus), 358, 359, 361, 363 brevis (Streptococcus), 337, 696 brevis o (Bacillus), 716 brevis non hemolyticus (Streptococcus), brevis var. rudensis (Lactobacillus), 357 359 brevissimum (Bacterium), 675 Brevistreptothrix, 892, 925 Briarcus, 1233 briensis (Nitrospira), 72 brightin (Streptococcue), 335 briosianum (Bacterrum), 639 briosii (Bacterium), 145 bronchiale (Treponema), 1065 bronchiglis (Actinomyces), 922 bronchialis (Discomyces), 922 bronchialis (Oospora), 922 bronchialis (Spirochaela), 1063 bronchialis (Spiroschaudinnia), 1365 bronchicanis (Bacillus), 562 bronchicanis (Bacterium), 562

bronchiseptica (Brucella), 562

bronchisepticus (Alcaligencs), 416, 562 bronchiseptieus (Bacullus), 562 bronchiseptieus (Bacterium), 562 bronchitica (Anaeromyces), 926 branchitica (Cahnistreptothrix), 926 bronchitidis (Bacillus), 739 bronchitidis putridae (Bacillus), 739 bronchapneumaniae (Ehrlichia), 1118 bronchopneumoniae (Miyagawanella), 1118 Brucella, 17, 26, 32, 42, 43, 560, 562 Brucella melitensis var. melitensis, 561 brumptis (Grahamella), 1110 bruneum (Carynebacterium), 403 bruneum y arborescens (Bacterium), 403 bruneus (Bacillus), 740 bruni (Actinomyces), 923 bruni (Discomices), 023 bruni (Nocardia), 023 brunneaflavum (Bacterium), 675 brunarostarus (Bacillus), 675 brunneum (Baeteridium), 650 brunneum (Bacterium), 650, 680, 737, 740 brunneum (Flarobacterium), 440 brunneus (Bacillus), 440, 650, 737, 740 brunneus (Micrococcus), 675 brunneus rigensis (Bacillus), 430 bruntzii (Bacillus), 644, 645 bruntzu (Serratia), 644 bubalorum (Clostridium), 778, 625 bubalseptica (Bacillus), 548 bubalseptica (Pasteurella), 548 bucallia (Bacterium), 440 buccale (Basterium), 365, 440 buccale (Borrelia), 1062 buccate (Spirillum), 1062 buccale (Spironema), 1062 buccale (Treponema), 1062 buccaits (Actinomyces), 922 buccalis (Ascococcus), 693 buccalis (Bacillus), 365, 650 buccalis (Discamyces), 922 buccalis (Flavobactersum), 410, 617 buccales (Leptospira), 1039 buccalss (Leptothrix), 365, 266 buccalis (Leptotrichia), 364, 365 buccalis (Micrococcus), 329

canalensis (Bacillus), 651 canaliculatus (Bacillus), 740 canalis (Bacterium), 675 canalis (Microspira), 202 canalis capsulatus (Bacillus), 675 canalis capsulatus (Bacterium), 675 canalis parvum (Bacterium), 675 canalis parvus (Bacillus), 675 canariensis (Bacillus), 530 canastel (Salmonella), 521 canceris (Baci.lus), 740 cancrosi (Bacterium), 587 candicans (Achromobacter), 423 candicans (Albococcus), 255 candicans (Bacillus), 423 candicans (Bacterium), 423 candicans (Coccus), 261 candicans (Micrococcus), 251, 232, 255, 257, 253, 259, 260, 262, 263, 264, 263, 269, 270, 273, 274, 275, 276, 277, 278, 279, 280, 281 candicans (Staphylococcus), 255 candida (Nocardia), 968 candida (Sarcina), 290 candida (Streptothrix), 934, 970 candidus (Actinomyces), 968 candidus (Bacterium), 401 candidus (Descomyces), 968 candidus (Micrococcus), 239, 251, 252, 253, 254, 255, 256, 258, 264, 265, 267, 269, 270, 271, 272, 274, 275, 278, 279, 281, 282 eandidus (Staphylococcus), 239, 282 canescens (Albococcus), 255 canescens (Micrococcus), 255 canescens (Sarcina), 290, 291 canescens (Staphylococcus), 255 caneus (Lactobacillus), 363 canicida (Bacterium), 553 canicola (Leptospira), 1077, 1079 canidae (Treponema), 1076 canina (Palmula), 812 canina (Spirochaeta), 1066 caninus (Acuformis), 812 caniperda (Bacillus), 740 canis (Actinomyces), 915

canis (Asterococcus), 1292

canis (Bacterium), 740 canis (Bartonella), 1104 canis (Cladothrix), 915 canis (Corynethrix), 406 canis (Ehrlichia), 1036 canis (Ehrlichia) (Rickettsia), 1995 canis (Haemobartonella), 1104, 1103, 1106 canis (Hemophilus), 587 canis (Nocardia), 915 canis (Oospora), 915 canis (Rickettsia), 1035 cania (Spirella), 217 canis (Spirochaeta), 1066 cania (Streptothrix), 915 ennis (Tarpeia), 1272 canis familiaris (Pleuromyces), 915 canis lupus (Grahamella), 1110 eaniseptica (Pasteurella), 553 cannabinus (Bacıllus), 813 eannae (Baclerium), 171 cannae (Phytomonas), 171 cannae (Pseudomonas), 171 cannae (Xanthomonas), 171 cantabridgensis (Ascococcus), 250 canus (Bacillus), 651 canus (Micrococcus), 267 capillaceus (Bacillus), 740 capillorum (Micrococcus), 255 capillorum (Palmella), 255 capillorum (Palmellina), 255 capillorum (Zoogloca), 255 capillosa (Ristella), 577 capiltosus (Bacillus), 577 capitovale (Clestridium), 795 capitavalis (Bacillus), 795 capitovalis (Plectridium), 795 cappelletti (Streptococcus), 317 capras (Actinomyces), 899 caprae (Cladothrix), 899 caprae (Discomyces), 899 caprae (Nocardia), 833 capras (Oospora), 899 caprae (Streptothrix), 899 capri (Bacıllus), 714 capriformis (Micrococcus), 255 caprinus (Streptococcus), 338

bulyrscum var. americanum (Clostradium), 819 bulyrscus (Bacillus), 716, 727, 740, 770, 813.820

butyricus (Micrococcus), 254, 338 butyricus (Streptococcus), 338 butyricus (Tetracoccus), 254

butyricus (Tetracoccus), 254
butyricus asporogenes immobilis (Baeillus), 790

butyricus dimorphus (Bacillus), 813 butyricus putrefaciens (Bacillus), 799 Butyrisarcina, 29, 30, 31, 285 byzantinea (Brucella), 693 buzantineum (Corcobacterium), 693

cacai (Actinomyces), 951
cacao; (Streptomyces), 951
Cacopiria, 12, 13, 28, 1055
cacticida (Errenio), 478
cacticida (Errenio), 478
cacticida (Bactinus), 478
cacticidus (Bactinus), 609, 675, 701, 799
cadarers (Bactinus), 705
cadarers (Edactrium), 675, 791
cadarers (Eubacterium), 307, 791
cadarers (Eubacterium), 307, 791
cadarers (Streptococcus), 338
cadarers bulyricum (Bacterium), 791
cadarers bulyricum (Bacterium), 791
cadarers bulyricum (Bacterium), 791
cadarers bulyricum (Bacterium), 367, 350,
701, 826

cadaceris grandis (Bacillus), 813
cadaceris sporogenes (Bacillus), 799
cadaceris sporogenes (Bacillus), 799, 820
Caduceus, 33, 31, 763
caducus (Phagus), 1141
cace: (Hacillus), 650
cacsia (Cellulamonas), 619
caesira retoriformi (Spirochaela), 1066
caesira experientionalis (Spirochaela)

1069
caestus (Bacsilus), 619
capae (Coccobacilus), 690
cajus (Racsilus), 690
calceum (Ferribacterium), 831
calceum (Siderobacter), 831
calceus (Bacsilus), 834

calciphila (Pseudomonas), 146
calciprecipitans (Pseudomonas), 108
calcis (Pseudomonas), 108
calcis (Pseudomonas), 108
calcis (Pseudomonas), 108
calca-acetica (Pseudomonas), 146
calca-aceticus (Micrococcus), 255
calendulae (Bacterium), 133
calendulae (Pseudomonas), 133
calendulae (Pseudomonas), 133

calendulae (Bacterium), 133
calendulae (Phylomonas), 133
calendulae (Paeudomonas), 133
calendulae (Paeudomonas), 133
calidalects (Bacillus), 732
calidas (Bacillus), 732
calidas (Bacillus), 732
californicus (Actinomyces), 936
californicus (Streptomyces), 936
californicus (Streptomyces), 936
californicus (Streptomyces), 936

calligyrum (Treponema), 1072 callistephi (Chlorogenus), 1146 callistephi var. attenuatus (Chlorogenus), 1147 callistephi var californicus (Chloroge-

nun), 1147
caloriolerans (Clostridium), 797
caloriolerans (Plectridium), 707
Calymmatobacterium, 14, 437
camel: (Actinomyces), 015
cameli (Oospora), 018
cameli (Streptothriz), 915
camelidae (Trepnema), 1076

cameli (Streptothriz), 915 camelidae (Treponema), 1070 campencus (Mierococcus), 255 campestro (Marmor), 1202

. .

campestris (Bacillus), 155
campestris (Bacterium), 155
campestris (Phylomonas), 155
campestris (Pseudomonas), 155
campestris (Nanthomonas), 155, 156, 160, 161, 178, 1181, 1136
campestris var. armoraciae (Phylomo-

campestris var. armoraciae (Phytomonas), 156, campestris var armoraciae (Xanthomo-

nas), 156, 164
canadensis (Bacillus), 759
canadensis (Bacterium), 759
canadiense (Clostridium), 819

viridifaciens Bergey et al., Manual, 2nd ed., 1925, 208), and Phytomonas vignas var. leguminophila Burkholder, Cornell Agr. Exp. Sta. Mem. 127, 1930, 51. Wilson (Phytopath., 30, 1940, 27) lists Phytomonas cerasi (Griffin) Bergey et al. (Pseudomonas cerasus Griffin, Science, 34, 1911, 615; Bacillus cerasus Holland, Jour. Bact., 5, 1920, 217; Bergey et al., Manual, 3rd ed., 1930, 262; Bacterium cerasi Elliott, Bact. Plant Pathogens. 1930, 109.) This would include, therefore the following synonyms which have been listed for Phytomonas cerasi. Clara (Cornell Agr. Evp. Sta. Mem. 159, 1934, 25) lists Bacterium trifoliorum Jones et al. (Jour. Agr. Res., 25, 1923, Phytomonas trifoliorum Burk-471: holder. Phytopath., 16, 1926. Pseudomonas trifoliorum Stapp, in Sorauer, Handb. d. Pflanzenkrankheiten, 2. 5 Aufl., 1928, 177) and Bacterium holci Kendrick (Phytopath., 16, 1926, 236; Pseudomonas hole: Kendrick, ibid.; Phytomonas holci Bergey et al., Manual, 3rd ed., 1930, 258). Wilson (Hilgardia, 10, 1936, 213) lists Pseudomonas prunicola Wormald (Ann. Appl. Biol., 17, 1930, 725). Pseudomonas cerasi var prunicola Wilson (Hilgardia, 8, 1933, 83), Bacterium citriputeale C. O Smith (Phytopath., 4, 69; Pseudomonas citriputealis 1913, Stapp, in Sorauer, Handb d. Pflanzenkrankheiten, 2, 5 Aufl , 1928, 190; Phytomonas citriputcalis Bergey et al , Manual, 3rd ed., 1930, 278) and Pseudomonas utiformica Clara, Science, 75, 1932, 111 (Phytomonas utiformica Clara, Cornell Agr. Exp Sta. Mem. 159, 1934, 29; Bacterrum utiformica Burgwitz, Phytopathogenic Bacteria, Leningrad, 1935, 444). A probable synonym is Phytomonas spongiosa (Aderhold and Ruhland) Ma-(Bacillus spongrosus Aderhold and Ruhland, Cent f. Bakt., 1I Abt., 15, 1905, 376; Pseudomonas spongiosa Braun, Die Landwirtschaft, 41, 42, 1927, 2 pp; Bacterium spongiosum Elliott, Man. Bact. Plant Pathogens, 1930, 214; Magrou, in Hauduroy et al., Dict. d. Bact. Path , Paris, 1937, 414). G. O. Smith

(Phytopath., 58, 1913, 82) lists the following as a synonym: Pseudomonas hibisei (Nakata and Takimoto) Stapp (Bacterium hibisei Nakata and Takimoto, Ann. Phytopath. Soc. Japan, 1, 5, 1923, 18; Stapp, in Sorauer, Handbuch der Pflanzenkrankheiten, 5 Aufl., 2, 1928, 203; Phytomonas hibisei Bergey et al., Manuals 3rd ed., 1930, 264).

Description from Clara (loc. cit.).

Rods: 0 75 to 1 5 by 1.5 to 3 0 microns. Motile with 1 or 2 polar flagella. Gramnegative.

Green fluorescent pigment produced in

Gelatin: Liquefaction.

Beef-extract agar colonics: Circular, grayish-white with bluish tinge. Surface smooth. Edges entire or irregular.

Broth: Turbid in 36 hours. No pellicle.

Milk: Alkalıne.

Nitrites not produced from nitrates.

Indole not produced.

No H:S produced. Not lipolytic (Starr and Burkholder,

Phytopath., 32, 1942, 601).
Slight growth in broth plus 4 per cent salt.

Acid but not gas from glucose, galactose, mannose, arabinose, xylose, suerose, mannitol and glycerol. Alkaline reaction from salts of citric, malic, succinic and lactic acid. Rhamnose, maltose, lactose, raflinose, salicin, and acetic, formic and tartaric acid not fermen ed.

Starch not hydrolyzed.

Facultative anacrobe. Source: Van Hall originally isolated the pathogen from lalac.

Habitat: Pathogenic on lilac, citrus, cow peas, beans, lemons, cherries and many unrelated plants.

81a. Orsini reports the following as a variety—Bacterium syringae var. capsici Orsini. (Intern. Bull Plant Prot., 33, 1942, 33) Pathogenic on the pepper plant (Capsicum).

82 Pseudomonas atrofaciens (McCulloch) Stevens. (Baeterium atrofaciens

eapriseptica (Pasteurella), 553 eaprisepticus (Bacillus), 553 caprogenes (Bacterium), 753 cantogenes foctidus (Bacillus), 753 caproicum (Clostridium), 820 capsaformans (Micrococcus), 255 capsici (Bacillus). 740 Capsularis, 33, 34, 577 capsulata (Klebsiella), 450 cansulata (Pseudomonas), 93, 146 eavsulata (Rhodasphaera), 865 capsulatum (Acetobacter), 189 capsulatum (Bacterium), 459 eapsulatum (Rhodobacterium), 863 capsulatum (Rhodonostoc), 864 capsulatus (Bacillus), 459 cansulatus (Bacterium), 691 capsulatus (Diplococcus), 308 capsulatus (Mycococcus), 891 capsulatus (Rhodococcus), 8, 865 capsulatus (Rhodopseudomonas), 864, capsulatus (Rhodorrhagus), 865 capsulatus (Streptococcus), 308, 338 capsulatus aerogenes (Bacıllus), 789, 790 capsulatus anacrobius (Bacillus), 790 capsulatus chinensis (Bacıllus), 456 capsulatus gallinarum (Streptococcus). 339 capsulatus margarineus (Diplococcus),

capsulatus margarineus (Dipiococcus), 662 capsulatus mucosus (Bacillus), 459 capsulatus mucosus (Bacterum), 459 capsulatus pyarmiae cuniculi (Bacillus),

capsulatus pycemac currents, 450
450
capsulatus septicus (Bacillus), 601
capsulatus septicus (Bacillus), 601
capsulatus septicus (Potenty, 601
earabica (Sterepure), 605
carabica (Sterepure), 636
carabica (Sterepure), 636
carabica (Sterepure), 636
carabica (Sterepure), 636
carabica (Terponema), 1072
carbo (Sterepore), 255
catbonei (Clostidium), 807
carboni (Clostidium), 807
carboni (Sterepure), 637
carboni (Sterepure), 756
Carbonia (Sterepure), 757
carbonia

cardiff (Salmonella), 512 cardii (Vibrio), 203, 205 cardii-papiltosi (Cristispira), 1056 eardii papillosi (Spirochacta), 1056 cardio-orthritidis, 320 cardiopurocenes (Spirillum), 217 carduus (Coceus), 250 caricae (Marmor), 1201 coria (Bacillus), 816 carnea (Cladothrix), 968 carnea (Nocardia), 968 carnea (Oospora), 968 carnea (Sarcina), 200 carnea (Streptothriz), 968 carnegicana (Erwinia), 468 carneum (Bacterium), 675 carneus (Actinomuces), 968 carneus (Bactilus), 675 carneus (Discomucce), 968 carneus (Micrococcus), 255 carneus (Sirepiococcus), 338 carneus halophilus (Tetracoccus), 284 carnicolor (Barillus), 675 carnicolor (Micrococcus), 255, 276 carniphilus (Bacillus), 740 carniphilus (Micrococcus), 255 carnis (Bacillus), 651, 810 carpia (Clostridium), 810 carnis (Plectridium), 810 carnis (Streptococcus), 338 carnis foetidum (Clastridium), 787 carnis saprogenes (Bacillus), 782 carnofoetidum (Clastridium), 787 carnosum (Bacterium), 675 carnosus (Actinomyces), 968 carnosus (Baeillus), 740 earocyanca (Pseudomonas), 146 carocyaneum (Baeterium), 146 earocyancus (Baeillus), 146 earogeanui (Cohnistreptothrix), 928 earolina (Salmanella), 531 carolinus (Bacilius), 531 carotae (Phytomonas), 165 carotac (Pseudamonas), 165 carotae (Nanthomonas), 165 carotarum (Bacillus), 714 carotarum (Bacterium), 714

carotovora (Erwinia), 469, 470, 471, 474, 1129, 1134, 1135, 1136 carolovorum (Bacterium), 469 carotovorum (Pectobactersum), 464, 469 carotovorus (Bacillus), 469 carougeaus (Actinomyces), 928 carougeaui (Discomyces), 928 carougeaui (Nocardia), 928 carougeaus (Streptothrix), 928 carpanoi (Treponema), 1074 carpathiens (Bacillus), 361 Carphococcus, 235 Carpophthora, 1151 carrau (Salmonella), 528 carrosus (Streptococcus), 338 carteri (Borrelia), 1061, 1068 carters (Spirillum), 1061 carters (Spirochaeta), 1061 cartera (Sparonema), 1061 carters (Spiroschaudinnes), 1061 carteri (Troponema), 053 Carteria, 925 Carteris, 925 cartharinensis (Micrococcus), 255 cartilagineum (Bactersum), 675 cartilagineus (Bacillus), 675 Caryococcus, 1121 Caryophanon, 1004 caryophyllacearum (Bacillus), 639 caryophyll: (Phytomonas), 137 carvophylli (Pseudomonas), 136 caser (Actinomyces), 968 casei (Bacterium), 718 case: (Cellulomonas), 619 case: (Lactobacillus), 356, 357 cases (Micrococcus), 240 caser (Planococcus), 281 casei (Plocamobacterium), 695 casci (Propionibacterium), 379 casei (Sarcina), 290 case: (Streptobacterium), 355, 361 case: (Streptococcus), 338 cases (Tetracoccus), 284 casei a (Bacillus), 356 caser y (Bacıllus), 358 cases & (Bacillus), 360

casei e (Bacıllus), 352

casei a (Bacterium), 356 casei e (Bacterium), 352 casci acido proteolyticus I (Microcaccus), 240, 326 casei acido-proteolyticus II (Micrococcus), 240, 326 casei amari (Micrococcus), 326 casei amarı edamicus (Micrococcus), 256 casei filans (Bacterium), 354 casei limburgensis (Bacillus), 612 casci limburgensis (Bacterium), 612 cases liquefacions (Micrococcus), 240, 323 casei liquefaciens (Tetracoccus), 240 casci proteclutious I and II (Micrococcus), caseia (Cellulomonas), 619 casescola (Bacterium), 676 caseinicum (Achromobacter), 692 Caseobacterium, 8, 349 Caseobacterium e, 352 Caseococuus, 327 caseolytica (Sarcina), 291 caseolyticum (Bacterium), 371 caseolyticus (Bacillus), 631 caseolyticus (Micrococcus), 240, 253, 259, 260, 263, 265, 266, 268, 278, 635 cassavae (Bacterium), 466 cassavae (Erwinia), 466 castaneae (Bacterium), 138 castancae (Phytomonas), 133 castaneae (Pseudomonas), 138 castanicolum (Bacterium), 640 castellanii (Castellanus), 513 castellanii (Micrococcus), 253 castellanii (Rhodococcus), 255 castellanii (Shigetla), 512 Castellanus, 535 castelfum (Bacterium), 676 casligala (Cellulomonas), 615 castigatum (Bacterium), 615 castra (Vibrio), 203 catarrhalis (Actinomyces), 922 catarrhalis (Bacillus), 590 catarrhalis (Discomyces), 922 catarrhalis (Micrococcus), 298 catarrhalis (Neisseria), 298, 299, 301 catarrhalis (Oospora), 922

catarrhalis (Pseudomonas), 146 Catenabacterium, 33, 34, 368 catenaforme (Catenabacterium). 369 catenaformis (Bacterordes), 368 catenatus (Thermobacillus), 731 catenula (Bacillus), 676, 823 catenula (Bacierrum), 676 catenula (Cornilia), 823 catenula (Tyrothrix), 823 catenulatus (Bacillus), 740 catenulatus (Chondromyces), 1039 cathetus (Bacillus), 651 eati (Actinomyces), 969 cali (Discomyces), 969 cattleyae (Bacterium), 759 eauearien (Dispora), 351 equentica (Pacinia), 351 caveasieum (Bacterium), 351 equeasicum (Belabacterium), 351, 358 equeasious (Bacillus), 351, 358 caucasicus (Lactobacillus), 351 equeasions (Streptococcus), 338 caudata (Pseudomonas), 174, 405 eaudatum (Flarobacterium), 174 caudatus (Bacillus), 174, 405 caudatus (Bacterium), 174 caudatus (Coccus), 250 Caulobacter, 35, 832 cararum pericarditis (Bacterium), 551 caratum (Bacterium), 676 caternae (Baclertum), 676 envernae minidiasimus (Bacillus), 676 carrae (Actinomyces), 912 cariae (Bacillus), 651 caviac (Bacteroides), 574, 580 carrae (Bartonella), 1108 carrae (Cristispirella), 1057 carrae (llaemobartonella), 1105 cariae (Klebsiella), 518 caviae (Nocardia), 912 carrae (l'asteurcila), 553, 651 cariae (l'seudomonas), 146 eartae (Spherophorus), 574, 580 eartae (Spirochaeta), 1071 eartae (Spironema), 1070 carrae (Spiroschaudinnia), 1070 carrae (Streptobacillus), 574

cavine fartustum (Bacterium), 676 carrae fortuitus (Bacıllus), 676 caricida (Bacıllus), 445 cavicida (Bacterium), 445 cancida (Escherichia), 445 cancida havaniensis (Bacillus), 676 carreida havaniensis (Bacterium), 676 cariseptica (Pastcurella), 553 cansepticum (Bacterium), 553 eazaubon (Bacterium), 759 cazaubon I and II (Bacterium), 750 celebense (Bacterium), 169 celebensis (Phytomonas), 169 celebensis (Pseudomonas), 169 celebensis (Xanthomonas), 169 celer (Phagus), 1142 cellaris (Leucocustus), 255 cellaris (Micrococcus), 255 ecllasea (Cellulomonas), 618 cellascus (Bacillus), 618 Cellfalcicula, 211 cellobioparus (Clostridium), 820 cellulicola (Schinzia), 224 Cellulobacillus, 8, 705, 763 cellulolyticum (Plectridium), 823 Cellulomonas, 20, 32, 615, 616 cellulomonas (Praleus) var. Proteus biaroteus, 617 cellulomonas (Proteus) var. Proteus castaneus, 622 cellulomonas (Proleus) var. Proleus rossteus, 622 cellulomonas (Proteus) var. Proteus udus, cellulosae (Actinomyces), 938 . . cenmosae nyarogenicus var. ceilulosae methanicus (Caduccus), 810

cellulosae melhanteus (Caduceus), 810

cellulosam fermentans (Bacillus), SOS

cellulosam (Bactersum), 808

cellulosis (Bacterium), NY)

cellulosolrens (Caduceus), Nr.

cellulosolvens (Clostridium), 809 cellulosum (Angiococcus), 1048 cellulosum (Polyangium), 1027, 1028 cellulosum (Sorangium), 1022 cellulosum fermentans (Terminosporus). cellulosum var. ferrugineum (Polyangium), 1010, 1028, 1029 cellulosum var. fulvum (Polyangium). 1029 cellulosum var. fuscum (Polyangium), 1010, 1028 cellulosum var. luteum (Polyangium), 1029 Cellvibrio, 209 Cenomesia, 847 centrale (Anaplasma), 1100 centralis (Bacillus), 651 centricum (Baeterium), 676 centrifugans (Bacillus), 101, 697 centrifugans (Bacterium), 697 centrifugans (Pseudomonas), 101, 697 eentropunctatum (Achromobacter), 423 centropunctatus (Bacillus), 423 centropunctatus (Bacterium), 423 eentropunctatus (Micrococcus), 255 centrosporogenes (Bacillus), 787, 825 centrosporogenes (Clostridium), 787 Centrosporus, 20, 22 centrosporus (Bactilus), 725, 741 cepae (Bacellus), 740 cepac (Marmor), 1184 rephaloideus (Bacillus), 816 cepivora (Phytomonas), 470 cepivorum (Bacterium), 470 ecpivorus (Aplanobacter), 470 cepivorus (Bacillus), 470 ceramicola (Bacterium), 626 ceramicola (Flavobacterium), 626 verasi (Bacterium), 120 cerasi (Marmor), 1197 cerasi (Phytomonas), 120 cerasi var. prunicola (Pseudomonas),

cerasi wraggi (Bacterium), 153

cerası wraggi (Phytomonas), 153

cerasinus (Micrococcus), 255, 256, 338

cerasinus (Streptococcus), 333 cerasinus lactis (Micrococcus), 255 cerasinus siccus (Micrococcus), 333 cerasus (Bacillus), 120 cerasus (Pseudomonas), 120 cereale (Lactobacillus), 355 cereale (Thermobacterium), 355 cerealia (Pseudomonas), 740 ccrealium (Bacillus), 740 cerealium (Bacterium), 740 cerebralis (Corynebacterium), 403 cerebriformis (Actinomyces), 969 ccrebriformis (Chondrococcus), 1046 cerebriformis (Muxococcus), 1046 cerebriformis (Nocardia), 969 cerebriformis (Streptothrix), 969 cereus (Actinomyces), 969 cereus (Bacillus), 703, 715, 716, 717, 713, 719, 725, 1138 cereus (Micrococcus), 256 cereus (Staphylococcus), 251 cereus albus (Micrococcus), 251 cereus albus (Staphylococcus), 251 cereus aureus (Micrococcus), 258 cereus aureus (Staphylococcus), 256 cereus flavus (Mierococcus), 256 cereus flavus (Staphylococcus), 256 (Bacillus), var. Augrescens 716 cereus var. mycoides (Bacillus), 718 cereus var. siamensis (Bacillus), 716 cerevisiae (Flavobaeterium), 176 cerevisiae (Lactobacterium), 363 cerevisiae (Merismopedia), 249 cerevisiae (Micrococcus), 219 cerevisiae (Pediocrecus), 249 cerevisiae (Pseudomonas), 176 cerevisiae (Sarcina), 249 cerinum (Bacterium), 676 cerinus (Gluconoacetobacter), 694 cerinus (Micrococcus), 256 cerro (Bacterium), 529 cerro (Salmonella), 529 ceruminis (Bacillus), 403 ceruminis (Corynebacterium), 403 cervina (Sarcina), 291 ceylonensis (Shigella), 542, 543

eylonensis A (Bacillus), 540 evionensis B (Bacellus), 512 enlonensis B (Lankvides), 542 cholcea (Actinomyces), 978 chalcea (Micromonospora), 959, 978 chalcea (Nocardia), 978 chalcea (Streptothrix), 978 chalmersi (Actinomyces), 975 ehalmersi (Nocardia), 975 chamae (Cristispira), 1056 ehamae (Spirochaeta), 1056 Charon, 1265 charring (Bacellus), 651 charrini (Streptococcus), 338 chausaci (Bacıllus), 776 chauraei (Clostridium), 776 chausei (Clostridsum), 776 Chauroea, 20, 22, 763 chausoei (Bacıtlus), 776 chausoei (Baetersum), 776 ehauroei (Butyrsbacillus), 776 chauvoei (Clostridium), 776 chelonei (Mycobacterium), 886 chersonesia (Mierococcus), 256 chester (Salmonella), 504 chinense (Aerobacter), 456 chinense (Bacterium), 456 chinseus (Micrococcus), 256 chironomi (Bacterium), 635 chironomi (l'hotobacterium), 635 chitinochroma (Bacterium), 632 chitinophilum (Bacterium), 631 chitinovorus (Bacillus), £32 Chlamydothrix, 12, 18, 984 Chlamydozoca, 1114 ehlorina (Pelogloca), 870 chlorina (Pseudomonas), 95 chlorinum (Bactertum), 95, 654, 676 chlorinus (Bacillus), 95, 651 chlorinus (Micrococcus), 256 Chlorobacterium, 693, 673 Chlorobium, 29, 30, 669 Chlorochromatium, 673 Chlorogenus, 1148 Chloronium, 873 Ch'oronostoc, 800

Chlorophaena (Pseudomonas), 146

Chlaronseudomonas, 870 chlororaphis (Bacillus), 93 chlororaphis (Pseudomonas), 93 chlarum (Flavobacterium), 440 chocolatum (Chromobacterium), 693 cholerae (Bacillus), 194 cholerae (Bacterium), 547 cholerae (Phagus), 1142 cholerae (Vibrio), 194, 195, 1142 cholerae anatum (Bacillus), 552 choleraeasiaticae (Pacinia), 193 cholerge asialicae (Spirillum), 193 eholerae asialicae (Vibrio), 194 cholerae-caviae (Bacillus), 502 eholerae columbarum (Baeillus), 552 cholerae columbarum (Baciersum), 552 cholerae gallinarum (Bacıllus), 547 cholerae gallinarum (Bacterium), 547 cholerae gallinarum (Microeoceus), 547 eholerae gallinarum (Octopsis), 547 cholerae gallinarum (Pasteurella), 547 eholerac-surs (Bacillus), 508 eholerae-suis (Bacterium), 508 cholerae-suis (Bacterium) (Salmonella). choleraesuis (Salmonella), 493, 494, 495, 508,509 cholerae suis var. Lunzendorf (Salmon. ella), 509 510 cholerae suum (Bacillus), 508 cholerae suum (Bacterium), 508 choleroides (Bacillus), 198 choleroides (Bacterium), 702 choleroides (Mierospira), 198, 203 choleroides a and \$ (Vibrio), 203, 702 cholesterolicum (dlycobacterium), 890 chologenes (Bacillus), 676 chologenes (Bacterium), 676 chondri (Streptothrix), 976 Chondrococcus, 1009, 1044 Chondromyces, 14, 17, 20, 24, 26, 1036 choukeritchi (Bacıllus), 612 ehristiei (Bacterium), 759 ehristophersoni (Aetinomyces), 975 christophersoni (Nocardia), 975 Chromatium, 16, 23, 25, 29, 30, 816, 552, 833, 856, 857, 859

chromidrogenus citreus (Micrococcus), 256 chromidrogenus ruber (Micrococcus), 256 chromoaromaticus (Bacillus), 657 chromo-aromaticus (Bacterium), 657 Chromobacterium, 20, 32, 37, 223, 231, 694 chromoflavus (Micrococcus), 256 chromogenes (Cladothrix), 969 chromogenes (Clostridium), 805 chromogenes (Oospora), 969 chromogenes & alba, (Actinomyces) 934 chromogenus (Actinomyces), 934, 940, 969, 970, 972 chromogenus 205 (Actinomyces), 941 chroococcum (Azotobacter), 219 chroococcus (Bacillus), 219 Chroostipes, 872 chrysanthemoides (Vibrio), 203 chryseum (Bacterium), 676 chryseus (Bacıllus), 672 chryseus (Micrococcus), 256 chrusoologa (Bacterium), 676 chrysoglosa (Bacillus), 676 chylogena (Eberthella), 533 chulogenes (Bacillus), 450, 533 chyluriae (Bacillus), 651 chymogenes (Bacterium), 452 cichorii (Bacterium), 133 cichorii (Phutomonas), 133 cichorn (Pseudomonas), 125, 133 ciliatus (Lactobacillus), 363 Cillobacterium, 33, 34, 369 eineinnatus (Bacillus), 813 einctus (Bacillus), 740 cinerea (Neisseria), 209, 301 cinereo-niger (Actinomyces), 969 cinereoniaeraromaticus (Achnomyces), 969 cinereo-nigra (Nocardia), 969

cinered-nigra (Nocarata), 301
cinereus (Micrococcus), 301
cinereus (Streptococcus), 338
cinereus niger aromaticus (Actinomyces),
989

cineronigra aromatica (Streptothrix), 969 cinnabareus (Micrococcus), 244, 255, 256, 257, 274, 275

cinnabareus (Rhodococcus), 244 cinnabarinus (Micrococcus), 256

circulans (Bacillus), 722, 728, 737, 78, circulans (Bacterium), 722 circularis major (Bacillus), 580 circularis minor (Bacillus), 362 curhiformia (Micrococcus), 236 cirrhosus (Chondrococcus), 1045 cirrhosus (Myzococcus), 1045 cirroflagellosus (Bacillus), 741 cissicola (Aplanobacter), 134 cissicola (Pseudomonas), 134 Citivir, 1209 citrarefaciens (Bacterium), 119 citrarefaciens (Pseudomonas), 119 citrea (Nocardia), 208, 975 citrea (Sarcina), 288, 291 citrea (Streptothrix), 969 citrea conjunctivae (Sarcina), 291 citreum (Bacterium), 651, 676, 687 citreum (Semiclostridium), 762 citreus (Actinomyces), 946, 969 citreus (Ascobacillus), 651 citreus (Bacıllus), 651, 676 citreus (Enterococcus), 336 citreus (Micrococcus), 239, 242, 254, 256 257, 261, 265, 268, 278, 280, 339 citreus I (Micrococcus), 256 cutreus II (Micrococcus), 256, 275 citreus (Mucococcus), 891 citreus (Planococcus), 288 citreus (Proactinomyces), 908 citreus (Staphylococcus), 242 citreus (Streptococcus), 338 citreus (Streptomyces), 946 citreus baregensis (Microbacullus), 690 citreus cadaversis (Bacillus), 687 citreus cadaveres (Bacterium), 687 citreus conglomeratus (Diplococcus), 299 citreus conglomeratus (Merismopedia), 239

230 ctreus conglomeratus (Micrococcus), 232 ctreus duodenalis (Slaphylococcus), 303 ctreus granulatus (Micrococcus), 256, 277 ctreus ilquefaciens (Diplococcus), 257 ctreus ilquefaciens (Micrococcus), 257 ctreus ilquefaciens (Micrococcus), 257 ctreus regenso (Micrococcus), 257 ctreus regenso (Micrococcus), 257 ctreus regensos (Mic

estri (Bactersum), 156 citri (Phagus), 1135 citri (Phytomonas), 156 citri (Pscudomonas), 156 citri (Xanthomonas), 156, 1129, 1134, 1135, 1136 citri deliciosae (Bacterium), 178 citricus (Bacillus), 651 citrimaculans (Bacitlus), 475 citrimaculans (Bacterium), 475 citrimaculans (Erwinia), 475 citrina (Sarcina), 291 citrinus (Bacillus), 651 citrinus (Micrococcus), 257 citriputeale (Bacterium), 119, 120, estrupuleolis (Phytomonas), 120 brireputcalis (Pseudomonas), 120 Citrobacter, 448 citrocremeus (Actinomyces), 915 eitrophilum (Achromobacter), 510 estrophilum (Urobacterium), 610, 691 estrophilus (Streptococcus), 339 citrovorum (Leuconostoc), 347 estrororus (Streptococcus), 347 entrovorus paracitrovorus (Streptococcus). Cladoscus, 12, 13 cladogenes (Bacillus), 651 eladoi (Bacıllus), 741, 758 Cladothrix, 6, 17, 18, 917, 980, 982, 1121 elasbornes (Salmonelta), 518 elathratiforme (Aphanothece), 871 clathratiforme (Pelodictyon), 871, 872 Clathrochloria, 872 Clathrocystis, 6, 847 claratus (Bacillus), 400, 813 elaratus (Myzococcus), 1015 clarifer (Actinomyces), 969 clavifolium (Aureogenus), 1157 clariforme (Bacterium), 823 clariformis (Bacillus), 651, 823 elaviformis (Micrococcus), 257 clariformis (Pacinia), 823 clariformis (Tyrothriz), 823 elemo (l'seudomonas), 694 eleoni (Bacillus), 632 Clonca, 10

eloaca (Microspira), 202, 203, 206 cloacae (Actinomyces), 969 oloacae (Aerobacter), 455, 456, 457, 460, 670, 692 eloacae (Bacıllus), 455, 457 eloacoe (Bacterium), 455 cloacae (Cloaca), 455 Clonothrix, 12, 17, 19, 26, 35, 933 elonotricoides (Mycothrix), 983 closteroides (Bacıllus), 722, 741 clostridiiformis (Bacterium), 576, 577 elostridisformis (Ristella), 576 clostriditformis mobilis (Zuberella), 577 clostridioides (Bacillus), 720 Clostridrum, 11, 22, 27, 30, 31, 33, 42, 43, 76, 216, 367, 763 Clostrillium, 7, 705 Clostrinsum, 7, 705 coadunata (Pscudomonas), 101, 697 coadunatum (Achromobacter), 101 coadunatus (Bacillus), 101 coadunatus (Bocterium), 637 coagulans (Bacillus), 531, 713 coagulans (Bacteroides), 567, 577 coagulans (Ballanella), 531 coagulans (Clostridium), 782 coagulans (Pasteurella), 587 coagulans (Salmonella), 531 cobayae (Bacillus), 714 cobayae (Borrelia), 1066 cobayae (Spirochaeta), 1066 cobayae (Treponema), 1066 coccacea (l'seudomonas), 146 cocciforme (Bacterium), 403, 693 eoeciformis (Brucella), 693 eoccineum (Thiospirillum), 859, 859 coccineus (Bacillus), 652, 711 coccineus (Micrococcus), 257 Coccobscillary bodies (Nelson), 1291 Coccobacillus, 516, 1291 Coccobacterium, 479 coccordes (Eperythrozoon), 1112, 1113 coccoides (Nitroscey stis), 72, 73 coccoideum (.1chromobacter), 423 eoccoideum (Bacterium), 423 cocendeus (Bacillus), 710 Coccomonas, 11

conjunctivitis (Bacterium), 590 connii (Achromobacter), 423 connii (Bacterium), 423 conordeus (Micrococcus), 257 conori (Dermacentrozenus), 1088 conorii (Rickettsia), 1087, 1088, 1092 conradi (Pscudomonas), 146 consolidus (Bacillus), 741 constans (Marmor), 1167 constellatum (Bisidibacterium), 369 constellatus (Bacillus), 369 constellatus (Diplococcus), 310 constrictus (Bacillus), 652 constrictus (Bacterium), 652 contextus (Bacillus), 741 continuosus (Streptococcus), 339 contumax (Phagus), 1136 convexa (Pasicurella), 571 convexa (Pseudomonas), 96, 697 convexus (Bacteroides), 571, 577 convoluta (Nocardia), 919 convoluta (Oospora), 919 convolutum (Mycobacterium), 919 convolutus (Actinomyces), 919 convolutus (Bacillus), 652 convoltus (Bacterium), 652 convolutus (Discomyces), 919 coprocinus (Bacillus), 753 coprogence, (Bacilius) 813 coprogenes foctidus (Bacillas), 652, 813 corrogenes parvus (Bacillus), 514 coprogenese parvus (Bactersum), 544 coproliticus (Thiobacillus), 80 coprophila (Microspira), 202, 206 coprophilum (Bacterium), \$19 coprophilum (Spirillum), 206 coprophilus (Bacillus), 819 coralinus (Rhodococcus), 258 corallina (Nocardis), 897, 902, 903, 904 corallina (Pseudomonas), 697, 1016 corallina (Serratia), 614, 902 corallinum (Clostridium), 820 corallinus (Micrococcus), 258 corallinus (Proactinomyces), 902 corallinus (Streptohrix), 902 coralloides (Chondrococcus), 1006, 1045, 1046

coralloides (Micrococcus), 258 coralloides (Myxococcus), 1045 coralloides var. clavatus (Chondrococcus), 1015 coralloides var. polycyslus (Chondrocorcus) 1045 Corium, 1203 cornecta (Gallionella), 832 Cornilia, 705, 763 cornutum (Bifidibacterium), 809 cornutus (Bacillus), 369 cornutus (Bacteroides), 369 coronafaciens (Bacterium), 116 coronafaciens (Phytomonas), 116 coronafaciens (Pseudomonas), 113, 115 coronafaciens var. atropurpurea (Phytomonas), 116 coronafaciens var. atropurpurea (Pseudomonas), 116 coronafaciens vas. alropurpurcum (Bacterrum), 116 coronata (Microspira), 636 coronata (Siderocapsa), 831 coronatum (Photobacterium), 636 coronatus (Bacillus), 652 coronatus (Micrococcus), 339 coronatus (Streptococcus), 239 coroniformis (Actinomyces), 969 corruppins (Bacillus), 741 corrugatus (Micrococcus), 259 corruleo-ciride (Bacterium), 652 corruscans (Bacillus), 741 corticale (Bacterium), 677 corticalis (Bacellu ), 677 corvi (Bacıllus), 052 corylei (Bacterium), 640 corylina (Phytomonas), 156 corylina (Xanthomonas), 156 Corynebacterium, 7, 17, 18, 21, 22, 23, 27, 30, 35, 37, 38, 42, 381, 382, 391, 396, 400, 401, 403, 404, 405, 407, 435, 612, 615, 633, 866, 927 Corynemonas, 8, 381 Corynethriz, 381, 407 Corynobaclerium, 12, 13, 19, 28, 381 coryzae (Diplococcus), 258 coryzae (Micrococcus), 259

coryzae contagiosae equorum (Streptococcus), 317 coryzae segmentosus (Bacullus), 406 coscoroba (Bocillus), 453, 557, 552 coscorobo (Escherichia), 453 coscorobae (Bacterium), 453 costatus (Bacillus), 741 costicolus (Vibrio), 702 costiculus var. liquefaciens (Vabrio), 702 cotti (Microspironemo), 1074 cotti (Treponema), 1074 couch: (Grahamella), 1110 courmontis (Bacillus), 652 couvys (Leptospira), 1078 couryi (Spirochaeta), 1078 Cowdria, 1094, 1097 Coxiella, 1092 crassa (Klebstella), 459 crassa (Leptothrix), 985 crassa (Simonsiella), 1004 crasse (Caryophanon), 1004 crassum (Bacterium), 459 crassum (Plocamobacterium), 400 crassum (Spirillum), 203, 217 crassum (Thiospirillum), 851 crassus (Bacillus), 362, 400, 652 crassus (Diplococcus), 297, 301 erassus (Microeoccus), 301 crassus (Vibrio), 203 erassus aromaticus (Bacıllus), 146 erassus procence (Bacillus), 652 crassus pyogenes boris (Bacillus), 652 crassus sputigenus (Bocillus), 459 crassus var. D (Vibrio), 203 erosteri (Vibrio), 201 eraterifer (Actinomycce), 969 cremoides (Bacterium), 403 cremoides (Corynebacterium), 403 eremoides (Micrococcus), 213, 258 cremoides albus (Vicrococcus), 258 cremoides aureus (Micrococeus), 253 eremoris (Bacıllus), 709 eremoris (Streptococcus), 321, 325, 339, 340, 1138, 1139 eremarisciarosi (Vierococcus), 258

eremaris riscosi (Staphulococcus), 238

erenalum (Bacterium), 677

erenatus, Thiobacillus, 81 Crenothrix, 6, 12, 17, 18, 19, 23, 26, 987 crepusculum (Micrococcus), 258 erepusculum (Monas), 258 eresologenes (Bacillus), 813 cresologenes (Clostridium), 813 cretacea (Oospora), 969 cretaceus (Actinomyces), 969 eretaceus (Micrococcus), 258 cretus (Carvococcus), 1121 criceti domestici (Grahamella), 1110 cricetuli (Grahamella), 1110 crinatum (Bactersum), 741 erinitus (Bacillus), 652, 741 cristalliferum (Bacterium), 677 cristallino violaceum (Bacterium), 234 cristatus (Arthromitus), 1003 cristatus (Micrococcus), 258 Cristispira, 12, 19, 20, 26, 28, 42, 1055, 1056. Cristispirella, 1069 erocatus (Chondromyces), 1006, 1036, 1038 crocea (Cytophaga), 1016 eroc: (Bacıllus), 474 croc: (Erwinia), 474 crocidurae (Spirochaela), 1066 crocidurae (Treponema), 1066 cromogena (Streptotriz), 969 crouposa (Klebsiella), 458 cruciferarum (Marmor), 1176 cruciformis (Micrococcus), 258 eruciriae (Achromobacter), 103 cruciviae (Pseudomonas), 103 eruentus (Chondrococcus), 1012 cruentus (Myxococcus), 1042 cruores (Aclinomyces), 975 ernoris (Discompces), 975 cruoris (Nocardia), 975 cruorus (Oospora), 975 crystalloides (Bacillus), 741 erystaloides (Bacterium), 741 erystallophagum (Myrobactersum), \$97 erystallophagus (Actinomyces), E98 erystallophagus (Proactinomyces), 875 clenocephali (Ricketteia), 1096 etenocephali (Spirochaeto), 1005

ctenocephali (Treponema), 1066 cubana (Salmonella), 527 cubensis (Bacillus), 741 cubensis (Spirochaeta), 1066 cubonianum (Bacterium), 135, 693 cubonianus (Bacillus), 135, 652 cuculi (Bacillus), 403 cuculi (Corynebacterium), 403 cuculliferum (Chromatium), 853 cucumeris (Lactobacillus), 356 cucumeris (Marmor), 1155, 1173 cucumeris fermentati (Bacillus), 356 cucumeris fermentati (Ulvina), 695 cucumeris var. commelinae (Marmor). 1174 cucumeris var. judicis (Marmor), 1173. 1174 cucumeris var. lilii (Marmor), 1174 cucumeris var. phascoli (Marmor), 1174 cucumeris var. upsilon (Marmor), 1172 eucumeris var vignae (Marmor), 1174 cucumeris var vulgare (Blarmor), 1174 cucumis (Vibrio), 204 cucurbitae (Bactersum), 157 cucurbitae (Phylomonas), 157 cucurbitae (Pseudomonas), 157 cucurbitae (Xanthomonas), 157 cuenoti (Bacıllus), 652 culicis (Entomospira), 1066 culicis (Rickettsia), 1096 culicis (Spirillum), 1066 culicis (Spirochaeta), 1066 culicis (Spironema), 1066 culicis (Spiroschaudinnia), 1066 culteis (Treponema), 1066 cumini (Phytomonas), 121 cumini (Pseudomonas), 121 cumulatus (Micrococcus), 258, 278 cumulatus tenuis (Micrococcus), 278 cumulus minor (Coccus), 694 cuneatum (Bactersum), 776 cuncatus (Bacillus), 813 cuncatus (Vibrio), 193, 203, 205 cuniculi (Actinomyces), 578, 910, 928 cuniculi (Bacillus), 652 cuniculi (Baclerium), 402, 552

cuniculi (Cladothrix), 578, 928

cuniculi (Clostridium), 820 cuniculi (Cohnistreptothrix), 928 cuniculi (Corynebacterium), 403 cuniculi (Hemophilus), 589 cuniculi (Klebsiella), 459 cuniculi (Listerella), 400 cuniculi (Nocardia), 910, 928 cuniculi (Noguchia), 594 cuniculi (Oospora), 928 cuniculi (Pasteurella), 547 cuniculi (Spirochaeta), 1073 cuniculi (Streptococcus), 339 euniculi (Streptothrix), 578, 928 cuniculi (Treponema), 1073, 1076 cuniculi pneumonicum (Bacterium), 553 cuniculi pneumonicus (Bacillus), 552 cuniculisepticus (Bacillus), 547, 652 cuniculicida (Bacillus), 547, 552 cuniculicida (Bacterium), 547, 681 cuniculicida (Pasteurella), 517 cuniculicida havaniensis (Bacillus), 612 cuniculicida havaniensis (Bactersum), 612 cuniculicida immobilis (Bacıllus), 653 cuniculicida immobilis (Buclerium), 653 cuniculicida mobilis (Bacıllus), 552 cuniculicida mobilis (Bacterium), 552 cuniculicida thermophilus (Bacillus), 631 cuniculicida thermophilus (Baclerium), cuniculicida var. immobile (Bacterium), cuniculorum (Micrococcus), 271 cuniculi (Leptotrichia), 366 cupularis (Bacillus), 612 cupularis (Microcorcus), 259 cupuliformans (Nanus), 1207 cupuliformis (Micrococcus), 259 cursor (Bacillus), 716 curtissi (Micrococcus), 259 curvum (Bacterium), 188 curvum (Rhizobium), 224 cuticularis (Bacıllus), 677, 755 cuticularis (Bacterium), 677 cuticularis albus (Bacıllus), 755 cutirubra (Pseudomonas), 110, 412 cutirubra (Serratia), 110

cutirubrum (Baclerium), 110

McCulloch, Jour. Agr. Res., 18, 1920, 549; Phytomonas atrofaciens Bergey et al., Manual, 1st ed., 1923, 185, Stevens, Plant Disease Fungi, New York, 1925, 22) From Latin, ater, black, faciens, making, referring to the color of the lesion on wheat.

Rods: 0 6 by 1 to 2.7 microns. Long chains formed in culture Capsules present. Motile with 1 to 4 polar or bipolar flagella. Gram-negative

Green fluorescent pigment produced in culture,

Gelatin: Liquefied.

Beef-peptone-agar colonies Circular,

shining, translucent, white

Broth: Growth never heavy, slight

rim, and a delicate pellicle
Milk: Becomes alkaline and clears
Nitrites not produced from nitrates

Indole: Slight production

Hydrogen sulfide: Slight production Acid and no gas from glucose, galactose and sucrose.

Starch is slightly hydrolyzed

Optimum temperature 25° to 28°G Maximum 35° to 37°C and minimum below 2°C.

Acrobic.

Sources: Isolated from diseased wheat grains collected throughout United States and Canada.

Habitat: Gauses a basal glume-rot of wheat.

83. Pseudomonas cumini (Kovacevski) Dowson (Phylomonas cumini Kovnecvaki, Bull. Soc. Bot Bulgarie, 7, 1936, 27; Dowson, Trans. Brit. Mycol. Soc., 28, 1913, 10) From Greek cuminum, cumin; M. L. Cuminum, a generic anno

Rods 0.5 to 0.7 by 1 to 3 microns, occurring in chains and filaments. Mottle with 1 to 3 polar fligella. Gram-negative

Green fluorescent pigment formed in culture.

Gelatin: Rapidly liquefied

Potato agar colonies: Grayish-white, circular, glistening, smooth, butyrous Broth: Moderate turbidity. Pseudoroedoen. Milk: Not coagulated Casein peptonized.

Nitrites not produced from nitrates Indole not formed. No II-S formed.

Acid but not gas from glucose and sucrose. No acid from lactose or glycerol. Starch not hydrolyzed

Temperature range 5°C to 31°C.

Acrobie.

Source: Isolated from blighted eumin (Cuminum)

Habitat: Pathogenic on cumin and dill.

81 Pseudomonas desalana (Burholder) comb. nov. (B. pyoeyaneus saccharum Desai, Ind. Jour. Agr. Sci., 5, 1935, 391, Phytomomas desauma Burkholder, in Bergey et al., Manual, 5th ed., 1939, 174) Named for Desau who first solated the species.

Rods: 0 6 to 12 by 1.2 to 2.2 microns. Mottle with a polar flagellum. Gramnegative.

Green fluoreseent pigment produced in culture

Gelstin: Liquefaction.

Agar colonies: Grayish-blue. Itaised. Broth Light clouding. Pellicle.

Milk Peptonized without congulation. Nitrites not produced from nitrates.

Indole not formed.
Glucose, sucrose, luctose and glycerol

fermented nithout gas.

Starch Hydrolysis present
Optimum temperature 30°C.

Verobic

Source. Isolated from stinking rot of sugar cane in India and associated with a white non-pathogenic bacterium.

Habitat. Pathogenic on sugar cane, Saecharum officinarum.

85 Pseudomonas erodii Lewie, (Phytopath., 4, 1914, 231; Bacterium erodii. Lewis, ibid; Phytomonas crodii Bergey et al., Manual, 3rd ed., 1930, 255.). From Greek, erodius, heron; M.I. Erodium, a generic name.

Rods. 06 to 08 by 1.2 to 18 microns.

daressalaamensis (Salmonella), 519 dassonvillei (Actinomyces), 915 dassonvillei (Discomyces), 916 dassonviller (Nocardia), 916 dassonvillei (Streptothrix), 934 daucarum (Bacillus), 742 davensis (Spirochaeta), 1053 daytona (Salmonella), 513 de baryanus (Bacıllus), 813 debile (Bacterium), 677 debilis (Streptococcus), 339 debilitans (Legio), 1257 decalvens (Bacterium), 259 decalvens (Micrococcus), 259 decidiosus (Bacillus), 441 decidiosus (Bacterium), 441 deciduosa (Cellulomonas), 621 deciduosum (Flavobacterium), 441 deciduosus (Bacillus), 621 decipiens (Micrococcus), 259 deceptens (Pacinia), 696 decolor (Bacillus), 653 decolor (Micrococcus) (Streptococcus ?), 259 decolorans (Aerobacter), 456 decolorans (Citrobacter), 448 decolorans major (Bacillus), 653 decolorans minor (Bacillus), 653 decussata (Nocardia), 975 decussata (Oospora), 975 decussatus (Actinomyces), 975 decussatus (Discomyces), 975 defessus (Bacıllus), 653 deformans (Micrococcus), 259 deformans (Phagus), 1135 degenerans (Bacillus), 637 degenerans (Microspira), 637 degenerans (Photobacterium), 637 dehydrogenans (Flavobacterium), 613 dehydrogenans (Micrococcus), 613 delabens (Bactllus), 147 delabens (Bacterium), 698 delabens (Pseudomonas), 147, 697 delacourianus (Micrococcus), 259 delbrücku (Bacillus), 355 delbruckii (Lactobacterium), 355 delbrueckii (Lactobacillus), 355, 695, 762

delbruecki (Plocamobaclerium), 695 delbruecki (Ulvina), 695 delendae-muscae (Bacterium), 677 delesseriae (Bacterium), 625 delesseriae (Florobacterium), 625 delgadense (Photobacterium), 637 delgadensis (Microspira), 637 delicatulum (Achromobacter), 419 delicatulus (Bacillus), 419 delicatulus (Bacterium), 419 delicatum (Corynebacterium), 403 deliense (Bacterium), 677, 759 delmarvae (Achromobacter), 422 delphinii (Annulus), 1216 delphinii (Bacillus), 115 delphinii (Bacterium), 115 delphinii (Pectobacterium), 696 delphinii (Phytomonas), 115 delphinii (Pseudomonas), 115 delta (Bacillus), 653 delta (Bacterium), 653 demmei (Bacillus), 742 demmei (Micrococcus), 270 dendriticum (Achromobacter), 423 dendriticus (Bacıllus), 423 dendriticus (Bacterium), 423 dendrobii (Bacterium), 613, 610 dendroides (Bacillus), 718, 742 dendroporthos (Micrococcus), 259 deneksi (Vibrio), 196 denekii (Pacinia), 196 denieri (Alcaligenes), 416 denitrificans (Bacillus), 423, 411, 412, 653, 754 denitrificans I (Bacillus), 440 denitrificans II (Bacillus), 426 denitrificans (Bacterium), 440, 688 denitrificans I (Bactersum), 410 denstrificans (Chromobacterium), 441 denstrificans (Flavobacterium), 410, 688 denstrificans (Micrococcus), 260 denitrificans (Pseudomonas), 98 denstrificans (Sulfomonus), 80 denitrificans (Thiobscillus), 80 denitrificans (Vibrio), 426 denstrificans agilis (Bacillus), 422 denitrificans agilis (Bacterium), 423

cutirubrum (Flavobacterium) (Halobacterium), 110
cutis (Bactilus), 403
cutis (Corynebacterium), 403
cutis commune (Bacterium), 403
cutis communis (Bactilus), 403
cutis communis (Micrococcus), 251, 259
cutis communis (Staphylococcus), 259
cyancofluorescens (Bactilus), 145
cyancofluorescens (Patudomanas), 145,
146
cutine of the communis (Staphylococcus), 259
cyancofluorescens (Patudomanas), 145,
146
cutine of the communis (Bactilus), 233

cuancophosphorescens (Achromobacter)

631
cyaneo-phosphorescens (Bacillus), 631
cyaneo-phosphorescens (Vibrio), 631
cyaneum (Bacteridium), 259
cyaneum (Photobacterium), 631
cyaneus (Actinococcus), 623
eyaneus (Bacterium), 605

eyaneus (Bacterium), 605
eyaneus (Mierococcus), 259, 272
eyaneus (Nigrococcus), 259
eyaneus (Proactinomyces), 923
eyaneus-antibiolicus (Proactinomyces),

923

eganofuteus (Bacterium), 233
eyanogenes (Festadomonas), 92, 96
eyanogenes (Vibrio), 92
eyanogenes (Bacterium), 700
eyanogenes (Bacterium), 700
eyanogenes (Micrococcus), 237, 90
eyanogenus (Micrococcus), 237, 93
eyanotes (Aferbacterium), 630
eyanophos (Micrococcus), 630
eyanophos (Micrococcus), 630
eyanophos (Micrococcus), 630

cylon's prosporate (\*\*Autocolectrum\*)

cyloclates (Archromobacter), 420
cyloclates (Bacterum), 420
cyloclates (Bacterum), 420
cyloclates (Micrococcus), 220
cyloclate (Wibrio), 200
cyprau (Bactilus), 612
cyyn (Bactilus), 612
cyyn (Bactilus), 612
cyyn (Bactilus), 612
cyyn (Bactilus), 612
cyjn flacacus (Actinomyces), 919
cylindracus (Actinomyces), 919
cylindracus (Bicillus), 731
cylindracus (Chondromyces), 1033

Cylindrogloes, 873 cylindroides (Bacterium), 577 culindroides (Ristella), 577 cylindrosporum (Clostridium), 789 culindrosporus (Bacillus), 716, 718 evprinicida (Bacterium), 642 cuprinicida (Klebsiella), 642 eypripedia (Bacillus), 470 cypripedii (Erwinia), 470 custiformis (Bacillus), 653, 741 cystinovarum (Achromobacter), 416 cystiopoeus (Micrococcus), 259 custifidis (Bacillus), 653 cystitidis (Streptococcus), 339 Cystobacter, 1025, 1034 Cystodesmia, 14, 1036 Custoecemia, 14, 1021 eulaseum (Bacterrum), 741 cytaseus (Bacillus), 741 cuta seus var. zonalis (Bacillus), 741 eytolytica (Erwinia), 473 Cytophaga, 35, 583, 1005, 1009, 1010, 1012 cytophaga (Spirochaeta), 1049 eutophagus (Micrococcus), 250 eytophagus (Mycococcus), 1013 czaplewskii (Bacterium), 590

dactyoideus (Bacillus), 653
Dactylocona, 14, 1014
docunhae (Aehromobacter), 105
dacunhae (Recommona), 105
dahu (Steptolhriz), 305
dahu (Steptolhriz), 305
dahiae (Bacillus), 470
dahiae (Alarmor), 1179
dahiae (Niarmor), 1179
damnorus (Steptococcus), 250
damnorus (Steptococcus), 250
damnorus var. mucosus (Streptococcus),
250
danieus (Bacillus), 714
danteri (Bacillus), 714

dantesi (Micrococcus), 259 danubica (Microspira), 196 danubicum (Spirillum), 196 danubicus (Yibra), 196 danusi (Salmonella), 517 dar-estalaam (Salmonella), 519

Dicrobactrum, 13, 14, 479 Dicrospira, 12, 13, 192 Dicrospirillum, 12, 13, 28, 212 didelphis (Spirochaeta), 1066 Didymohelix, 23, 26, 29, 831 dieffenbachtae (Bacterium), 157 diessenbachiae (Phytomonas), 157 dieffenbachine (Xanthomonas), 157 difficile (Clostridium), 773 difficilis (Bacillus), 773 diffluens (Bacillus), 490, 653 diffluens (Cytophaga), 1015 diffluens (Micrococcus), 260 diffluens (Proteus), 490 diffragens (Bacillus), 813 diffusum (Flavobacterium), 429 diffusus (Bacillus), 429 diffusus (Bacterium), 429 digestans (Bacillus), 730 digitatus (Bacıllus), 653 digitatus (Muxococcus), 1045 dihydrovyacetonicum (Bacterium), 189 dilaboides (Bacillus), 720 dilatator (Caryococcus), 1121 dimorpha (Mycoplana), 191 dimorpha (Urosarcina), 294 dimorphobutyricus (Bacillus), 814 dimorphus (Bacillus), 352 dimorphus (Bacteroides), 352 dimorphus (Microcoecus), 260 dimorphus var longa (Bacillus), 352 diphtheria vitulorum (Oospora), 578 diphtheriae (Bacillus), 383 diphtheriae (Bacterium), 383, 401 diphtheriae (Corynebacterrum), 383, 384, 385, 406, 752, 1131, 1143, 1144 diphtheriae (Phagus), 1143 diphtheriae arium (Bacillus), 400 diphtheriae avium (Bacterium), 400 diphtheriae avium (Mycobacterium), 915 diphtheriae columbarum (Bacillus), 401 diphtheriae columbarum (Bactersum), 401 diphtheriae cunicult (Bacillus), 402 diphtheriae cuniculi (Bacterium), 402 diphtheriae ulcerogenes cutaneum (Corynebacterium), 406 diphtheria vitulorum (Bacillus), 401, 578

diphthericum (Microsporon), 383 diphthericus (Micrococcus), 200 diphtheriticus (Streptococcus), 260, 337 diphtheroides (Bacıllus), 401 diphtheroides (Coccobacillus), 402 diphtheroides (Corynebacterium), 388, 403 diphtheroides (Kokkobacillus), 402 diphtheroides brevis (Bacillus), 402 diphtheroides citreus (Bacillus), 406 diphtheroides gallinarum (Bacillus), 403 diphtheroides liquefaciens (Bacillus), 401, Diplectridium, 7, 763 Diplobacillus, 590 Diplococcus, 13, 17, 20, 31, 33, 42, 305 Diplostreptococcus, 312 disciformans (Bacillus), 368, 742 disciformans (Bacterium), 742 disciformons (Eubacterium), 368 disciformis (Angiococcus), 1047 disciformis (Bacillus), 742 disciformis (Myxococcus), 1047 discofoliatus (Actinomyces), 927 discoides (Neisseria), 293 Discomyces, 925 discophora (Chlamydothrix), 985 discophora (Leptothrix), 985 discophora (Megalothrix), 985 dispar (Actinomyces), 918 dispar (Bacillus), 510, 512, 513 dispar (Bacterium), 542 dispar (Discomyces), 918 dispar (Eberthella), 42, 512 dispar (Eperythrozoon), 1113 dispar (Microsporon), 918 dispar (Proshigella), 512 dispar (Shigella), 542 dispar (Sporotrichum), 918 disparis (Streptococcus), 339 Dispora, 349 disporum (Clostridium), 820 dissimilis (Bacillus), 653 dissimilis (Micrococcus), 260 dissolvens (Aerobacter), 472 dissolvens (A planobacter), 472 dissolvens (Bacterium), 472 dissolvens (Clostridium), 43, 809, 818

denitrificans fluorescens (Bacillus), 98 Denstrobacterium, 8 denstrofluorescens (Bacillus), 653 Denitromonas, 8, 83 dentale (Leptospira), 1078 dentalis viridans (Bacillus), 653 dentotus (Baci lus), 742 denticola (Spirochaeta), 1075 denticola (Spirochoete), 1075 denticola (Treponema), 1075 dentinum (Spirochaeta), 1075 dentrum (Fusiformis), 581 dentium (Leptospira), 1079 dentium (Micrococcus), 330 dentium (Spirillum), 1075 dentium (Spirochaeta), 1065, 1070, 1074, dentium (Spirochaete), 1075 dentium (Spironema), 1075 dentium (Streptococcus), 333 dentium (Treponema), 1074 dentium-steogyratum (Treponema), 1075 deprimata (Cytophaga), 1013 derby (Salmoncila), 503 derbyensis (Salmonella), 505 dermacentrophila (Rickettsia), 1006 dermacentrozenus (Rickettsia), 1037 dermatogenes (Micrococcus), 260 dermatogenes (Pseudomonas), 93 dermalonomus (Actinomyces), 916 dermordes (Baerllus), 653 dermophilum (Corynebacterium), 403 dermophilus (Hocillus), 403 derossii (Bacıllus), 803 derossis (Clostridium), 803 desaiana (Phytomonas), 121 desaiana (Pseudomonas), 121, 125 desidens (Micrococcus), 339 denidens (Streptococcus), 339 desidiosa (Cellulomonas), 621 desidiosum (Flarobacterium), 411 desidiosus (Bacterium), 441 desiduosis (Bacillus), 411, 621 desmodilli (Pasteurella), 553 desmol; licum (Achromobacter), 104 desmolyticum (l'scudomonas), 104

destillationis (Bacterium), 576

destillationis (Ristella), 576 destructans (Bacterium), 470 destructans (Phytomonas), 470 destructans (Pseudomonas), 470 destruens (Bacillus), 712 Desulfovibrio, 29, 30, 35, 82, 207, 209 desulfuricans (Bacillus), 207 desulfurieans (Desulfovibrio), 207, 208, 200 desulfuricans (Microspira), 207 desulfuricans (Spirillum), 207 desulfuricans (Sporovibrio), 207, 238 desulfuricans (Vibrio), 207, 208, 853 Detonsella, 983 detrudens (Bacıllus), 742 devorans (Bacillus), 430 devorana (Bacterium), 430 devorans (Flavobacterium), 430 devorans (Sarcina), 231 devorane (Vibrio), 204 dextranicum (Leuconostoc), 317 deztranicum (Streptobocterium), 701 deztranieus (Lactococcus), 347 dextrolacticus (Bacillus), 712 diacetilactis (Streptococcus), 330 diacetyl aromaticus (Streptococcus), 339 Dialister, 21, 27, 32, 33, 577, 591 Dialisterea, 20 dianth: (Bacillus), 640 dianthi (Bacterium), 640 dianthi (Pseudomonas), 610 diaphanus (Bacillus), 653 diaphthirus (Bacillus), 737, 793 diaporica (Rickettsia), 1002 diastasius (Thermobacillus), 731 diastaticus (Actinomyces), 039 diastaticus (Bocillus), 742 diastaticus (Streptomyces), 939 diastatochromogenes (Actinomyces), 911 diastatochromogenes (Streptomyces), ووالمراهم ومامثك

dienotomus (ophacrotitus), 932 dieksonii (Aelinomyces), 969 duplez non-liquefaciens (Hacillus), 592 duplez non-liquefaciens (Bacterium), 592 duplez non liquefaciens (Morazella), 593 duplez var. liquefaciens (Morazella), 591 duplez var. non liquefaciens (Morazella), 592 duplicatus (Bacillus), 693

5924 duplicatus (Bacillus), 693 duplicatus (Bacterium), 693 durplicatus (Bacterium), 693 durnbilis (Phagus), 1142 durnas (Sterptococcus), 327 durban (Salmanella), 519 dutton (Cacospira), 1060 duttoni (Spirallum), 1060 duttoni (Spirachaeta), 1060 duttoni (Spirachaeta) (Microspironema), 1060 duttoni (Spirachaeta), 1060 duttoni (Spirachaeta), 1060 duttoni (Spirachaeta), 1060

duttoni (Spiroschaudinnia), 1060 duttoni (Spiroschaudinnia), 1060 duttoni (Treponema), 1060, 1061, 1064, duttonii (Borrelia), 1060, 1061, 1064,

1969 dysenteriae (Bacillus), 536, 537, 538, 539, 540

dysenteriae (Bacterium), 536, 537, 689 dysenteriae (Eberthella), 536 dysenteriae (Phagus), 133 dysenteriae (Shigella), 535, 526, 537, 542, 1131, 1132, 1133, 1134, 1135

dysenteriae Boyd I to III (Bacillus), 538 dysenteriae Flexner I to VI (Bacillus), 538 dysenteriae Flexner VII and VIII (Bacillus), 538

dysenternae liquefaciens (Bacillus), 543 dysenternae liquefaciens (Bacillus), 536 dysenternae Schmits (Bacillus), 536 dysenternae vitulorum (Bacillus), 689 dysenteriae vitulorum (Bacillus), 689 dysenteriae vitulorum (Bacillus), 535, 543 Dysenteroudes, 10 dysyalactuae (Streptococcus), 319 dysodes (Bacillus), 742

easibourne (Salmonella), 519
ealonn (Micrococcus), 260
Eberthella, 10, 21, 26, 37, 42, 494, 616, 533
Eberthus, 10, 516

eburneus (Micrococcus), 200
echinata (Leptothrix), 255
eccemae (Micrococcus), 278
ecremicus (Bacillus), 654
edematis (Clostridium), 775
edgeworthiae (Bacillus), 478
edgeworthiae (Bruinia), 478
edgeworthiae (Bruinia), 478
edgeworthiae (Bruinia), 478
edgeworthiae (Bruinia), 1226
editoni (Meisseria), 301
efficiens (Marmor), 1129, 1192
efficenus (Thigus), 1443
effusa (Cellulomonas), 91
effusa (Tewdomonas), 91
effusa var.nonliqueforens (Pseudomonas),

effusus (Bacillus), 91, 718

egens (Bacillus), 790 epens (Clostridium), 700, 826 egens (Stoddardillus), 790 egregius (Bucillus), 654 egypticum (Treponema), 1065 Ehrenbergia, 37, 1052 chrenbergii (Bacillus), 597 ehrenbergii (Bacterium), 507 Ehrlichia, 1006 ehelichii (Grahamella), 1110 Eisenbergia, 12, 13, 486, 705 eisenbergis (Pseudomonas), 97, 98, 698 elaphorum (Bacternum), 145 elastica (Actinomyces), 969 elegans (Bacillus), 742, 814 elegans (Flexibacter), 38 elegans (Holospora), 1122 elegans (Thiodictyon), 845, 849 elipsoideus (Bacillus), 651 ellenbackensis (Bacillus), 715 ellenbachensis alpha (Bacıllus), 715 ellenbach: (Bacillus), 717 ellingers (Coccobacillus), 452 ellingeri (Escherichia), 452 ellingtonii (Bacillus), 654 ellipsoidea (Pseudomonas), 147 ellipsospora (Cytophaga), 1050 ellipsospora (Sporocytophaga), 1053 elongata (Pseudomonas), 698 elongala (Thiospira), 702

elusa (Spirochaeta), 1079

dissolvens (Erwinia), 464, 472 dissolvens (Phytomonas), 472 dissolvens (Pseudomonas), 472 Distasoa, 20, 21, 23, 27 distasonis (Bacteroides), 570 distasonis (Ristella), 579 distendens (Streptococcus), 347 distortus (Bacıllus), 742 distortus (Turothrix), 742 duersum (Acctobacter), 692 disersum (Aerobaeter), 456 ditersum (Citrobacter), 448 djoljakartensis (Microcaccus), 260 dmitrovi (Spirochaeta), 1078 dobelli (Bacillus), 742 dobelli (Bacıllus) (Flexilis), 742 dodecahedron (Marmor), 1169 doederlein (Laetobacillus), 362 docderleinzi (Acidobacterium), 362 domesticus (Bacıllus), 653 domesticus (Bacterium), 653 donnae (Actinamuces), 916 Donovania, 559 dori (Actinomyces), DIG dori (Discomyces), 916 dori (Nocardia), 916 dors (Ocenora), D16 dors (Rhinocladium), 916 dors (Sporotrichum), 916 dorige (Oospora), 931, 968 dormitator (Bacillus), 137 dormitator (Bacterium), 437 dormitator (Flavobacterium), 437 douglast (Bacillus), 514 douglass (Shroella), 514 Douglasillus, 11,763 dourdeswells (Urococcus), 282 dogeni (Bacellus), 651 doyent (Micrococcus), 200 drennani (Vibrio), 201 Drepanospira, 1122 drsmophylus (Micrococcus), 200 droebschense (Bacterium), 625 drochackense (Flavobactersum), 625 drochactense (Pseudomonas), 625 droserae (Bacillus), 6/3 droierae (Bacterium), 631

drosophilae (Treponema), 1075 dschunkowskii (Grahamella), 1110 dschunkowski (Grahamia), 1110 dubia (Eberthella), 533 dubitata (Palmula), 812 dubitatus (Acuformis), 812 dubium (Bacterium), 703 dubium (Marmor), 1172, 1214 dubium (Rhizobium), 225 dubius (Annulus), 1155, 1214 dubius (Bacıllus), 533 dubius (Bacterium), 533 dubius (Phagus), 1137 dubius pneumoniae (Bacıllus), 703 dubius var. annulus (Annulus), 1215 dubius var. flatus (Annulus), 1216

of the same about my / Am 1 at 1000 dublin var accra (Salmonella), 517 dublin var. Loeln (Salmonella), 517 duclauzis (Bacillus), 651, 742 duclaux: (Urobacillus), 651, 688, 729, 742 ducreyi (Coccobacillus), 587 ducreyi (Hemophilus), 537 dudischenkoi (Grahamella), 1110 duesseldorf (Salmonella), 514 dulcita-fermentans (Bacillus), 772, 821 dunbari (Microspira), 203 dunbaer (Photobacterium), 203 dunbari (Photospirellum), 203 dunbari (Vibrio), 702 duodenale (Baclerium), 417 duodenale (Encapsulata) (Bacıllus), 447 duplex (Baeillus), 590 duplex (Bacterium), 590, 831 duplex (Ferribaeterium), 831 duplex (Hemaphilus), 591 duplex (Maraxella), 592 duplex (Pseudomonas), 147 duptex (Siderobacter), 831 duplex (Siderocustis), 835

duplez (Sideroderma), 831

duplex josephi (Bacillus), 572

dupler josephi (Morazella), 502

duplex liquefaciens (Bacillus), 301

duplex liquefactens (Maraxella), 341

epidermidis (Bacillus), 742 epidermidis (Corynebacterium), 403, 406 epidermidis (Leptothrax), 691, 742 epidermidis (Micrococcus), 243, 252, 254, 255, 256, 259, 264, 265, 270, 271, 272 epidermidis (Plocamobacterium), 691 epidermidis (Staphylococcus), 213 epidermidis var. A (Albococcus), 243 epidermidis albus (Micrococcus), 243, 268 epidermidis albus (Staphylococcus), 243 epidermis (Micrococcus), 278 Epidermophyton sp., 921 epimetheus (Micrococcus), 260 epiphitica (Chlamydothriz), 986 epiphytica (Leptothrix), 985 epiphytica (Lyngbya), 986 cpiphytica (Streptothrix), 885 epiphytus (Bacillus), 743 eppingeri (Actinomyces), 896 eppingerii (Streptotrix), 896 epsilon (Bacillus), 654 sperion (Bacterium), 654 epsteinia (Achromobacter), 424 equae (Tortor), 1278 equarius (Streptococcus), 339 equatilis communis (Bacillus), 102 equestris (Malleomuces), 554 equi (Actinomyces), 920 equi (Bacıllus), 654 egus (Bactersum), 541 equi (Bollingera), 253 equi (Botryomyces), 253 equi (Corynebacterium), 391 equi (Corynethrix), 406 equi (Discomyces), 252, 920 egui (Mucobacterium), 391 equi (Nocardia), 920 equi (Sarcina), 290, 291, 292, 294 equi (Shigella), 541 equi (Spirillum), 1066 equi (Spirochaeta), 1066 equi (Spironema), 1066 equi (Spiroschaudinnia), 1066 equi (Streptococcus), 317, 318 equi (Treponema), 1066 equi intestinalis (Bacillus), 654

equi intestinalis (Bacterium), 654 equidistans (Bacillus), 1098 equina (Spirochaeta), 1068 equinus (Erro), 1253 equinus (Hostis), 1240 equinus (Streptococcus), 323, 339 equirulis (Bacillus), 541 equirulis (Shigella), 540 equiseptica (Pasteurella), 553 equisepticus (Bacillus), 553 equisimilis (Streptococcus), 318, 319 equorum (Tortor), 1277 equorum (Trifur), 1282 equuli (Bacillus), 541 erebea (Legio), 1259 erectum (Podangium), 1008, 1034 erectus (Chondromuces), 1034 erectus (Cystobacter), 1034 ersobotryae (Bacterium), 144 errobotryae (Phytomonas), 144 eriobotryae (Pseudomonas), 144 erivanense (Bacterium), 471 erivanensis (Bacillus), 471 erivanensis (Erwinia), 411 Ermengemillus, 11, 763 erodens (Bacillus), 743 erodens (Foliapellis), 1171 erodens (Marmor), 1171 erodens var. severum (Marmor), 1171 erodens var. vulgare (Marmor), 1171 erodii (Baclerium), 121 erodi: (Phytomonas), 121 erodii (Pseudomonas), 121 Erro, 1248 erubescens (Bacillus), 654 Erwinia, 31, 42, 443, 463, 476 erysipelalis (Micrococcus), 315 erysipelatos (Staphylococcus), 315 erysipelatos (Streptococcus), 315, 1139 erysipelatos-suis (Bacillus), 410 erysipelatos-suis (Erysipelothriz), 410 erysipelatos suum (Bacterium), 410 erysipelatosus (Streptococcus), 315 erysipeloides (Babesia), 411 erystpeloides (Streptothrex), 411 erysipeloidis (Actinomyces), 411 erystpeloidis (Bacterium), 411

elusum (Treponema), 1079 eminans (Bacillus), 654 emphysematis malign: (Bacıllus), 791 emphysematis raginae (Bacillus), 790, 826 emphysematosus (Bacillus), 789, 790 emphysematosus (Bactersum). 790 emulsinus (Bacillus), 654 emulsionis (Bacillus), 742 enalia (Pseudomonas), 698 Encapsulatus, 10, 17, 18, 457 encephaloides (Bacillus), 742 enchelys (Bacıllus), 677 enchelus (Bacterium), 677 endivide (Phytomonas), 133 endiviae (Pseudomonas), 133 Endobacterium, 705 endocarditicus (Streptococcus), 339 endocarduidis (Bacillus), 654 endocarditidis (Baclerium), 677 endocarditidis capsulatus (Bacillus), 677 endocarditidis griseus (Bacillus), 654 endocarditidis ariseus (Bacterium), 654 endocarditis (Cillobacterium), 369 endocarditis (Micrococcus), 274 endocarditie griseus (Bacillus), 401 endocarditis rugalus (Micrococcus), 274 endometritidis (Bacillus), 677 endometritidis (Bacterium), 677 endometritis (Plocamobacterium), 677 endometrilis canis (Bacterium), 677 endoparagogicum (Spirillum), 217 Endosporus, 33, 31, 763 englemannı (Bacıllus), 654 enterica (Eberthetta), 533 enterica (Escherichia), 450 enterious (Bacitlus), 450, 533 enterious (Enteroides), 450, 534 enterious (Proteus), 489 enteritidis (Actinomyces), 920 enterstides (Bacellus), 505, 516, 517, 782, 818, 920 enteritidis (Bacterium), 516 enteritidia (Discomyces), 920 enteritidis (Klebsiella), 516 enteritidis (Nocardia), 919 enteri(idis (Oospora), 920 ententidis (Phagus), 1136

enteritidis (Salmonella), 493, 497, 516, 517, 523, 531, 1130, 1136, 1137 enteritidis (Streptococcus), 339 enteritudia (Streptothrix), 919, 976 enteritidis breslau (Bacterium), 502 enteritidis breslaviense (Bacillus), 502 enteritidis sporogenes (Bacillus), 782, 818 enteritidis sporogenes (Clostridium), 818 enteritidis-vetlow (Salmonella), 531 enteratidis var chaco (Salmonella). 517 enteritidis var. danusz (Salmonella), 517 enteritidis var. dublin (Salmonella), 517 enteritidis var essen (Salmonella), 517 enteritidis var. jena (Salmonella). 517 enteritidis var. moscow (Salmonella), 518 enteritidis var mulheim (Salmonella), 517 enteritidis var rostock (Salmonella), 518 enteritidis B. Typ. equinus (Bacillus), 506 enteritidis B, Typ. murium (Bacillus), 502 enteritidis C, Typ opis (Bacillus), 506 enteritidis var. V (Salmonella), 531 enteritis (Streptococcus), 339 enteritis var. libmanii (Streptococcus). Enterobacter, 31, 32, 37 Enterobacterium, 37 Enterococcus, 326, 336 enterococcus (Diplococcus), 325 enterocoliticum (Bacterium), 677 Enteroides, 10 enteroideus (Micrococcus), 695 enteromyces (Bacıllus), 654 enterothrix (Bacıllus), 742 Entomospira, 12, 13, 28, 1058 entomotoxicon (Bacillus), 654 enzymicum (Corynebacterium), 388, 407 enzymicus (Bacıllus), 386 enzymothermophilus (Lactobacıllus), 363 eos (Mycobacterium), 905 Eperythrozoon, 1100, 1111, 1113 Eperythrozoon spp., 1113 ephemerocyanea (Pseudomonas), 147 ephestiae (Micrococcus), 260 ephestiae No. 1 and No. 2 (Bacterium). 759 epidemicus (Streptococcus), 315

epidermidis (Albococcus), 243

exanthematotyphi (Rickettsia), 1084 exanthematotyphi (Spirochaeta), 1067 exanthematotyphi (Treponema), 1067 exapatus (Bacillus), 655 excavatus (Micrococcus), 260 excurrens (Bacillus), 716 exedens (Bacillus), 631 exfoliatus (Actinomyces), 951 exfoliatus (Streptomyces), 951 exigua (Ristella), 569, 576 exiguum (Bacterium), 500, 655 exiguus (Bacıllus), 655, 743 exiguus (Bacteroides), 569, 576 exiguus (Micrococcus), 200 exiguus (Myxococcus), 1045 exiguus (Rabula), 1286 exilis (Bacillus), 352, 743 exitiosa (Phytomonas), 163 exitiosa (Pseudomonas), 163 exitiosum (Bacterium), 163 expositionis (Micrococcus), 260 expressus (Micrococcus), 261

fabae (Bacillus), 224 fabae (Phytomonas), 139 fabae (Pseudomonas), 139 fabas (Rhizobium), 224 faecalis (Alcaligenes), 413, 416 faccalis No. I (Bacillus), 755 faecales No. II (Bacellus), 753 faecalis (Streptococcus), 325, 326, 336 faecalis alcaligenes (Bacillus), 413 faecalis var. mariense (Alcaligenes), 416 faecalis var. radicans (Alcaligenes), 413 faecaloides (Bacillus), 544 faecalordes (Shigella), 514 faecium (Streptococcus), 325 faens (Aerobacter), 456 fairmountense (Achromobacter). 90 fairmountensis (Bacillus), 90 fairmountensis (Baclersum), 698 fairmountensis (Pseudomonas), 90, 698 falciformis (Leptothrix), 366 fallax (Bacillus), 773 fallax (Clostridium), 773 fallax (Spirochaeta), 1069 fallaz (Treponema), 1069

fallax (Vallorillus), 773 famiger (Bacillus), 655 farcini bovia (Streptothrix), 895 farcinica (Cladothrix), 895 farcinica (Nocardia), 895 farcinica (Oospora), 895 farcinica (Streptothrix), 895 farcinicus (Actinomyces, 895 farcinicus (Bacillus), 895 farcinicus (Discomyces), 895 farnetianus (Bacillus), 477 faschingii (Bacterium), 459 fascians (Corynebacterium), 395 fascians (Phytomonas), 395 fasciformis (Bacillus), 360 fastidiens (Marmor), 1189 fastsdiens var. denudans (Marmor), 1190 fastidiens var. fastidiens (Marmor), 1190 fastidiens var. mite (Marmor), 1190 fastidiens var. reprimens (Marmor), 1190 fastidiosus (Bacillus), 743 fausseki (Baetersum), 677 faviformis (Micrococcus), 261 febritis (Spirochaeta), 1079 febris (Spirochaeta), 1067 fecale (Flavobacterium), 416 fecale aromaticum (Bacillus), 416 fecalis alcaligenes (Bacterium), 413 fedder (Micrococcus), 201. festeli (Bacterium), 108 felidae (Treponema), 1976 felinus (Streptococcus), 339 felis (Bacillus), 655 felis (Bacterium), 553 felis (Cocco-bacterium), 655 felis (Miyagawanella), 1118 felis (Pasteurella), 553 felis (Tarpeia), 1271 felis (Tortor), 1279 felis septicus (Bacillus), 553 felis septicus (Bacterium), 553 felsineum (Clostridium), 806 felsineus (Bacıllus), 806 felsinus (Clostridium), 806 felthami (Pseudomonas), 693 Fenobacter, 705 ferarum (Pasteurella), 547

erysipeloidis (Erysipelothrix), 411 erystpeloidis (Oospora), 411 Ervsipelothrix, 18, 21, 22, 27, 28, 35, 37, 38, 409, 410

eruthematis (Bacillus), 742 erythematis (Bacterium), 742 eruthematis maliani (Bacillus), 742 eruthra (Pseudomonas), 147 eruthraeus (Bacillus), 641 eruthrea (Nocardia), 920 erythrea (Streptothrix), 920 eruthreus (Actinomyces), 938 erythreus (Streptomyces), 538 Eruthrobacillus, 10, 479 Erythrobacterium, 32 eruthrochromogenes (Actinomuces), 944 erythrochromogenes (Streptomyces), 941 Eruthroconia, 814 erythrogenes (Bacillus), 600 erythrogenes (Bacterium), 600, 601, 602 erythrogenes (Corynebacterium), 800 eruthrogenes (Eruthrobacillus), 600 erythrogenes rugatus (Bacillus), 654 erythrogloeum (Bacterium), 637 erythromyxa (Bacillus), 677 erythromyza (Bacterium), 677, 687 erythromyza (Micrococcus), 291 (Micrococcus) (Staphuloerythromyxa

coccus), 302, 677 eruthromuza (Rhodococcus), 8, 677 erythromyxa (Sarcina), 201 erythropolis (Actinomyces), 898 erythropolis (Mycobacterium), 898 erythropolis (Nocardia), 898 erythropolis (Proactinomyces), 898 erythrospora (Pseudomonas), 147 erythrospores (Bacillus) (Streptobacter),

erythrosporus (Baciltus), 147, 654 erythrosporus (Bacterium), 651 erzinjan (Salmonelta), 507 Escherichia, 3, 10, 21, 26, 31, 37, 443, 444, 418, 450, 458, 492, 691 escherichii (Bacillus), 445 essen 173 (Salmonella), 505

esseyana (Serratia), 481

esterificans (Bacillus), 43, 743

esterificans (Micrococcus), 260 esterificans (Plectridium), 743 esterificans fluorescens (Bacillus). 654 esterificans stralauense (Bacterium), 654 esteroaromaticum (Bacterium), 436 esteroaromaticum (Flavobacterium), 436 eta (Bacillus), 654 eta (Bacterium), 654 ethaceticus (Bacillus), 654 ethacetosuccinicus (Bacillus), 655 ethylicum (Eubacterium), 367 ethylicus (Amylobacter), 813 etousae (Shigella), 544 Eugeetobacter, 180 Euactinomyces, 929 Eubacillus, 9, 28 Eubacterium, 27, 28, 33, 34, 367 Euclostridium, 763 Eucystia, 13, 546 Eugluconobacter, 180 Eumyces, 876 euonymi (Marmor), 1187 euprima (Vibrio), 702

europaea (Nitrosomonas), 70 europaea (Pseudomonas), 70 europaca var. stalica (Nstrosomonas), 70 europaeus (Planococcus), 70 eurydice (Achromobacter), 421, 724 eurydice (Bacterium), 421 eurygyrata (Borrelia), 1066

eurygyrata (Spirillum), 1066 eurygyrata (Spirochaeta), 1066 eurygyrata (Spiroschaudinnia), 1066 eurygyratum (Spironema), 1006 eurygyratum (Treponema), 1067 euryhalis (Micrococcus), 605 eurystrepta (Spirochaeta), 1052 eutetticola (Chlorogenus), 1219

evagatus (Charon), 1265 eranidus (Bacrlius), 743 evansi (Brucella), 563 evolutus (Streptococcus), 332 exanthematica (Spirochaete), 1070 exanthematicum (Bacterium), 677 exanthematicus (Bacittus), 677 exanthematicus (Micrococcus), 260

Motile with 1 to 3 polar flagella. Gramnegative.

Green fluorescent pigment produced in culture.

Gelatin: Liquefaction.

Agar stroke: Heavy, smooth, creamcolored growth in 24 hours.

Broth: Dense clouding in 24 hours.

Milk: Turns alkaline and clears, litmus

reduced.

Nitrites not produced from nitrates.

Indole produced in 14 days.

No HaS produced.

Acid but not gas from glucose, sucrose, lactose and glycerol.

Temperature: No growth at 35°C.

Acrobic, obligate.

Source: Isolations from Erodium texanum and 4 varieties of Pelargonium.
Habitat: Causes a leaf apot of Erodium texanum and Pelargonium spp.

86. Pseudomonss apli Jagger, Jagger, Jour. Agr Res., 21, 1921, 186; Phytomonas apis Bergey et al., Manual, 1st ed., 1923, 184; Pseudomonas jaggeri Stapp, in Sorauer, Handbuch der Pfantenkrankhoiton, 2, 5 Auf., 1923, 210; Bacterium jaggeri Elliott, Bacterial Plant Pathogens, 1930, 142, Phytomonas jaggers Magrou, in Handuroy et al., Diet. d. Bact. Path, Paris, 1937, 371.) From Latin, apuum, parsloy, M.L. Apium, a generic name.

Description from Clara (Cornell Agr.

Exp. Sta. Mem. 159, 1934, 24).
Rods: 0.75 to 1.5 by 1.5 to 3.0 microns
Motile with a polar flagellum. Gram-

negative,
Green fluorescent pigment produced
in various media

Gelatin: Liquefaction.

Beef-extract agar colonies. Circular, glistening, smooth, edges entire Gray-

ish-white with bluish tinge

Broth: Turbid in 36 hours. Pellicle
formed.

Milk: Becomes alkaline. No curd Nitrites not produced from nitrates Indole not formed. No H.S formed.

Acid but not gas from glucose, galactose, fruetose, mannose, arabinose, xylose, sucrose, mannitol and glycerol. Alkaline reaction from salts of acetic, citrie, malic and succinic acids. Ikhamnose, maltose, lactose, raffinose, salicin, and formic, lactic and tartaric acid are not utilized.

Starch not hydrolyzed.

Facultative anacrobe.

Distinctive characters: Pathogenicity appears limited to celery.

Source: Jagger isolated this repeatedly from diseased celery leaves.

Habitat: Pathogenic on celery, Apium graveolens.

87. Pseudomonas matthiolae (Briosi and Pavarino) Dowson. (Bacterium matthiolae Briosi and Pavarino, Atti deliReale Accad. dei Lincei Rend., £1, 1912, 216; Phytomonas matthiolae, Bergey et al., Manunl, 3rd ed., 1930, 266; Mushin, Proc. Roy. Soc. Victoria, 55, 1941, 201; Dowson, Trans. Brit. Mycol. Soc., £8, 1943, 10.) From M.L. Matthiola, a generie namo.

Rods: 0.4 to 0.6 by 2 to 4 microns. Gram-positivo. Gram-negative (Mushin, loc. cit.).

Green fluorescent pigment produced in culture.

Gelatin: Liquefied.

Beef agar colonies: White, circular colonies, slightly elevated, marrins smooth.

Broth: Slightly turbid. Becomes pale green.

Milk: Coagulation with acid react'on-Nitrites produced from nitrates (Mushin).

Hydrogen sulfide not formed.

Acid from glucose, galactose, fructose, mannese, rhamnese, glycerol, mannitol, ecetie acid, eitric acid, formic acid, lactic acid, malie acid, and succeinic acid. Feeble acid in maltose. No acid, no gas in lactose, sucrose, raffinose, starch, salicin, and tartaric acid (Mushin).

Optimum temperature 20 to 24°C.

fermentans (Flavobacterium), 172 fermentans (Pseudomonas), 172 fermentatae (Lactobacillus), 358 fermentations (Achromobacter), 424 fermentationis (Bacillus), 655 fermentationis (Bacterium), 424 fermentationis cellulosae (Bacillus), 809 fermenti (Lactobacıllus), 359, 380 fermenti (Micrococcus), 340 fermenti (Strentococcus), 340 fermentosus (Wesenbergus), 534 fermentum (Lactobactersum), 360 ferophilum (Bacterium), 677 ferrarsi (Pacinsa), 690 ferrigenus (Bacillus), 743 ferruginea (Cellulomonas), 620 ferruginea (Chlamydothrix), 831 ferruainea (Didymohelix), 831 ferruginea (Gaillonella), 831 ferruginea (Gallionella), 831, 832 ferruginea (Glocotila), 831 ferruginea (Itersonia), 1044 ferruginea (Nocardia), 975 ferruginea (Spirochaete), 831 ferruginea (Spirulina), 831 ferruginea (Toxothrix), 984

ferrugineum (Polyangium), 1031 ferrugineum (Spirillum), 831 ferrugineum (Spirophullum), 831 ferrugineum (Spirosoma), 831 ferrugineus (Actinomyces), 975, 969 ferrugineus (Bacillus), 620, 655 ferruginia (Glocosphaera), 831 fertilis (Bacillus), 655 fervitosus (Micrococcus), 261 fesers (Bacillus), 776 feseri (Clostridium), 775, 776 festinus (Bacillus), 743 fetus (Spirillum), 201 fetus (Vibrio), 201 fibrosus (Bacıllus), 814 fici (Bacterium), 640 fici (Phytomonas 1), 640 fickis (Micrococcus), 261

ficks (Pacinio), 800
figurans (Bacillus), 855,718
figurans (Bacillus), 718
figirans (Bacterium), 718
figirans (Balla), 1157
filamentosu (Palmula), 800
filamentosum (Bacterium), 743
filamentosum (Catendoacterium), 885
filamentosum (Clostridium), 800
filamentosum (Clostridium), 800
filamentosum (Clostridium), 800
filamentosum (Clostridium), 800

filamentosus (Acuformis), 800 filamentosus (Bacillus), 743 filamentosus (Bacillus), 603 filamentosus (Laccibacitus), 603 filamentosus (Bacillus), 713 filamentosus (Bacillus), 743 filefacens (Bacillus), 743 filefacens (Bacillus), 743 filforne (Bacillus), 743 filforne (Bacillus), 743 filforne (Bacillus), 759 filiome (Clostridium), 799

filisormis (Leptothriz), 366 filiformis (Nocardia), 969 filiformis (Simonsiella), 1004 filiformis (Turothrix), 743 filiformis havaniensis (Bacillue), 679 filiformis havaniensis (Bacterium), 679 fima (Corynebacterium), 303 fimbriala (Pseudomonas), 147, 698 fimbriatus (Actinomyces), 939 fimbriatus (Bacillus), 147 fimbriatus (Bacterium), 698 fimentaria (Sarcina), 291 fim: (Bacillus), 396 fin: (Bacterium), 396, 397 fim: (Cellulomonas), 396 fimicarius (Actinomyces), 940 fimicarius (Streptomyces), 910 finitimum (Bacterium), 678 finitimus ruber (Rocellus) RES 2-0

finlayensis (Micrococcus), 261 firmus (Bacillus), 713 fischeli (Streptococcus), 340 fischer: (Achromobacter), 633 fischeri (Bacillus), 633, 635 fischeri (Microspira), 633 fischeri (Photobacterium), 633, 634, 635, Aareum (Bakterium), 678 fischeri (Vibrio), 633 Fischerinum, 13 fissum (Clostridium), 773 fissuratus (Bacillus), 743 fissus (Bacillus), 773 fitz (Bacterium), 771 fitzianum (Bacterium), 743 fitzianus (Bacillus), 743 flabelliferum (Clostridium), 783 flaccidifex (Gyracoccus), 250, 261 flaceidifex danai (Micrococcus), 261 flaccumfactens (Bacterium), 309 flaccumfaciens (Corynebacterium), 398, 399 flaceumfaciens (Marmor), 1193 flaccumfaciens (Phytomonas), 399 flaccumfactens (Pseudomonas), 399 flacheriae (Borrelina), 1227 flagellatus (Bacillus), 833 flagellatus (Micrococcus), 261 flagellifer (Bacillus), 743 flava (Cellulomonas), 618 flava (Hydrogenomonas), 77, 78 flava (Neisseria), 298, 299 flava (Nocardia), 908 flava (Sarcina), 253, 288, 290, 291, 292, 293, 294 flava (Streptothrix), 923, 969, 975 flava begoniae (Phytomonas), 155 flava varians (Merismopedia), 240 flavens (Micrococcus), 261 flaveolus (Actinomyces), 936 flaveolus (Streptomyces), 936 flavescens (Bacillus), 441, 669, 744 flavescens (Celivibrio), 210 flavescens (Flavobacterium), 441 flarescens (Micrococcus), 261 flavescens (Neisseria), 299 flavescens (Nocardia), 913

flavescens (Pneumococcus), 697 flavescens (Proactinomyces), 913 flavescens (Sarcina), 291 flavescens (Spirillum), 201 flarescens (Spirosoma), 204 flavescens (Vibrio), 203, 204 Aavicula (Cytophaga), 1016 flavida (Erwinia), 471 flavidescens (Bacillus), 655 flavidum (Corynebacterium), 406 flavidus (Bacillus), 406, 471, 744 flavidus (Micrococcus), 261 flavidus alrei (Bacillus), 744 flavigena (Bacillus), 622 flavigena (Cellulomonas), 622 Flavimacula, 1202 Flavobacter, 427 Flavobacterium, 20, 31, 32, 81, 427, 440, 442, 533, 609, 1296 flavochromogenes (Actinomyces), 941 flavochromogenes (Streptomyces), 941 flarocoriaceum (Bacterium), 678 flavocoriaceus (Bacillus), 678 flavocyaneus (Staphylococcus), 282 flarefuscum (Bacterium), 678 flatogriseus (Actinomyces), 969 flavoides (Bacillus), 655 flavotennae (Flavobacterium), 439 flacovirens (Actinomyces), 940 flarovirens (Micrococcus), 261 flavovirens (Streptomyces), 940 flavoviridis (Bacıllus), 741 Ravozonata (Bacterium), 155 flavozonatum (Xanthomonas), 155 flavum (Archangium), 1019 flavum (Bacterium), 678 flavum (Flavobacterium), 411 flavum (Microbacterium), 370 flavum (Mycobacterium), 370 flavum (Netrobacter), 76 flatum (Polyangium), 1019 flarum (Semiclostridium), 762 flavum (Spirillum), 201 flarum (Spirosoma), 201 flarus (Actinomyces, 923, 945, 969, 970, 975

.

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2000 - 10

fluorescens nivalis (Bacterium), 693 fluorescens non-liquefociena (Bacillus). 98, 145, 149 fluorescens non-liquefociens (Baeterium), fluorescens ovalis (Bacillus), 97 fluorescens ovalis (Bacterium), 699 fluorescens putidus (Bacillus), 96, 149, 699 fluorescens putidus colloides (Bacillus). fluorescens pulridus (Bacillus), 96 fluorescens schuylkilliensis (Bacterium). fluorescens septicus (Bacillus), 94 fluorescens lenuis (Bacıllus), 149, 656 fluorescens tenuis (Bocterium), 656, 701 Suorescens undulatus (Bacillus), 149, 744 Fluoromonas, 11, 83 fluxum (Plectridium), 793, 826 foedans (Bacillus), 367 foedans (Eubacterium), 367 foersteri (Actinomyces), 970 foersleri (Cladolhrix), 970 foerslers (Cohnistreptothrix), 970 foersleri (Discomyces), 970 foersteri (Nocardia), 970 foersters (Oospora), 970 foersters (Streptothrix), 934, 970, 977 foetida (Bacterium), 531 foetida (Cornilia), 787 foctida (Escherichia), 531 foelida (Solmonella), 531 foetidissimus (Bacillus), 656 foetidum (Clostridium), 787, 820, 826 foetidum (Paraplectrum), 782, 825 foetidum (Plectridium), 782 foetidum carnis (Clostridium), 787, 826 foetidum fecale (Clostridium), 820 foetidum lactis (Clostridium), 818 foetidus (Bacillus), 534, 656, 787 foetidus (Endosporus), 782 foetidus (Micrococcus), 262, 329, 339 foetidus (Streptococcus), 262, 329, 340 foetidus var. buccolis (Streptococcus), 329 foetidus clostriduformis (Bacillus), 787

foetidus lactis (Bacillus), 660

foetidus liquefaciens (Bacillus), 424, 655

foelidus ozaenae (Bacillus), 658 foetidus ozaenae (Bacterium), 658 foetidus ozenae (Coccobacillus), 531 foelus ovis (Vibrio), 201 folia (Cellulomonas), 618 foliacea (Pseudomonas), 147, 698 foliaceus (Bacillus), 744 foliicola (Bacillus), 678 foliicola (Bacterium), 678, 685 forans (Spirochaeta), 1070 forans (Spirochaete), 1070 forans (Treponemo), 1070 fordii (Actinomycea), 958 fordii (Streptomyces), 958 formica (Escherichia), 452 formicum (Achromobacter), 452 formicum (Bocterium), 452 Formido, 1263 formosanum (Baclerium), 133, 1136 formosum (Achromobacter), 424 formosus (Bacillus), 424, 745 formosus (Bacterium), 424 fortis (Vibrio), 702 fortissimus (Bacillus), 656 fossicularum (Bacıllus), 800, 814 foulertoni (Aelinomyces), 920 foulertoni (Discomyces), 920 foulertoni (Nocardia), 920 foutini (Bacillus), 744 Fractilinea, 1159 fradiae (Streptomyces), 954 fradii (Actinomyces), 951 fraenkelii (Bacterium), 145, 260 fragariae (Blastogenus), 1207 fragariae (Marmor), 1195 fragariae (Nanus), 1207 fragariae I (Pseudomonas), 100 fragariae II (Pseudomonas), 100, 101 fragaroidea (Pseudomonas), 100, 101 fragi (Bacterium), 100 fragi (Pseudomonas), 100 fragilis (Bacillus), 566, 501, 826 fragilis (Bacteroides), 32, 586, 575 fragilis (Fusiformis), 568 fragilis (Merismopedia), 262 fragilis (Micrococcus), 262 fragilia (Phagus), 1140

fragilis (Recordillus), 823 fragilis (Ristella), 32, 566, 575 franças (Grahamella), 1110 frankei (Bacıllus), 744 frankii var. majus (Rhizobium), 224 frankii var. minus (Rhizobium), 224 franklandsorum (Micrococcus), 262 fraxini (Pseudomonas), 132 freeri (Actinomyces), 896 freeri (Discomyces), 896 freers (Nocardia), 896 freeri (Oospora), 896 freeri (Streptothrix), 896 frequens (Vibrio), 703 freudenreichit (Bacillus), 744 freudenreichit (Micrococcus), 233, 251 252, 257, 260, 263, 264, 255, 256, 269, 272, 274, 275, 277, 284 freudenreichu (Propionibacterium), 373, 374, 375, 376, 377, 376 freudenreicher (Urobacellus), 741 freud: (Spherophorus), 579 freundu (Bacterium), 448, 678 freundis (Bacteroides), 579 freunds: (Cstrobacter), 448 freunds: (Colobactrum). 448 freundi: (Escherichia), 448, 460 friburgensis (Bacillus), 886, 890 friburgensis (Mycobacterium), 888, 890 friedebergensis (Bacillus), 530 friedebergensis (Bacterium), 530 friedlander (Bacterium), 458 friedlanderi (Bacillus), 458 friedlanders (Coccobacillus). 458 friedlanderi (Klebsiella), 458 friedmanii (Bacillus), 886 friedmannis (Mycobacterium), 883, 884, 855, 886, 887, 890 fructovorans (Lactobacellus), 363 frutodestruens (Bacillus), 744 fucatum (Flavobacterium), 436 fuchsina (Serratia), 484, 701 fuchsinus (Bacillus), 484 fuchsinus (Erythrobacillus), 484 fuchsinus (Proteus), 701

fucicola (Bacterium), 627 fulgurans (Spirochaeta), 1053, 1054 fulininosus (Bacıllus), 656 fulminans (Bacıllus), 717 fulva (Neisseria), 301 fulva (Sarcina), 291 fulvissimus (Actinomuces), 946 fulvissimus (Streptomyces), 946 fulyum (Bacterium), 605 fulvum (Flavobacterium), 605 fulvum (Rhodospirillum), 666 fulous (Bacillus), 805, 656 

fulvus (Myxococcus), 1008, 1041 fulvus (Rhodococcus), 8, 258, 281, 1041 fulrus var. albus (Muxococcus), 1041 fulvus var. miniatus (Myzococcus), 1041 fumeus (Bacillus), 656 fumigatus (Bacillus), 612 fumosum (Polyangium), 1032 fumosus (Bacillus), 656 funduliformis (Bacillus), 566 funduliformis (Bacteroides), 563, 579, 1295 e. \_ A. 120 . . ---. ...

fungoides (Bactersum), 678 fungosus (Bacillus), 656 funicularis (Bacillus), 744, 614 furcabilis (Cladascus), 13 furcosa (Ristella), 575 furcosus (Bacellus), 575 furcosus (Bacteroides), 575 furcosus (Fusiformis), 575 furens (Tortor), 1280 furvus (Bacillus), 744 fusca (Actinomyces), 924, 970 fusca (Cellfalcicula), 211 fusca (Clonothrix), 963, 987 fusca (Crenothrix), 983 fusca (Micromonospora), 979 fusca (Nocardia), 923 fusca (Oospora), 923 fusca (Sarcina), 201 fusca (Streptothrix), 923 fuscans (Bacillus), 656

fuscescens (Bacillus), 656
fuscescens (Bacterium), 657
fuscescens (Sarcina), 201
fuscum (Bacterium), 611, 678
fuscum (Chromobacterium), 611
fuscum (Flavobacterium), 611
fuscum (Polyangium), 1006, 1008, 1030
fuscum var. relatum (Polyangium), 1006,
1030
fuscus (Bacillus), 611, 650, 652, 657, 678,

fuscus (Cystobacter), 1030
fuscus (Discompees), 923
fuscus (Micrococcus), 262, 277
fuscus (Vibrio), 204
fuscus limbatus (Bacillus), 656
fuscus limbatus (Bacterum), 657
fuscus liquefaciens (Bacterum), 650
fuscus laquefaciens (Bacterum), 650
fuscus pallidior (Bacillus), 653
fuscus pallidior (Bacterum), 653
Fusibacillus, 20, 22

fusiforme (Corynebacterium), 581 fusiforme (Rhabdockromatium), 851 Fusiformis, 13, 18, 19, 28, 30, 34, 38, 581, 683 fusiformis (Bacillus), 581,728

fusiformis (Bacteroidea), 22
fusiformis (Fusiformis), 531
fusiformis (Rhabdomonas), 554
fusisporus (Bhabdomonas), 554
fusisporus (Bacillus) (Streptobacter), 744
Fusohacterum, 18, 27, 37, 581, 583
Fusoid (Bacillus), 744
futilis (Phagus), 1144

gabritschewskii (Actinomyces), 970
gadi (Microspironema), 1067
gadi (Spironema), 1067
gadi (Spironema), 1067
gadi (Mreponema), 1067
gadi (Mreponema), 1067
gadi pollachii (Spironhacta), 1069
gadidarum (Diplococcus), 289
gadidarum (Pediococcus), 289
gaeriner (Bacillus), 516
Gaffka, 33, 34
Gaffkya, 29, 31, 34, 283, 284

Gaillonella, 831 Galactococcus, 235 galactophila (Escherichia), 452 galactophilum (Bacterium), 452 galba (Cellulomonas), 617 galbanatus (Micrococcus), 262 galbus (Bacıllus), 617 Galla, 1157 galleriae (Bacterium), 759 galleriae No. 1 (Bacterium), 759 galleriae No. 2 (Bacterium), 759 galleriae No. 3 (Bacterium), 760 galleriae (Streptococcus), 340 galli (Tortor), 1279 gallica (Spirochaeta), 1067 gallicidus (Micrococcus), 262 gallicolum (Treponema), 1075 gallicum (Treponema), 1067 gallicus (Actinomyces), 959 gallicus (Streptomyces), 959 gallei (Clostridium), 820 gallinae (Legio), 1262 gallinae (Pasteurella), 547 gallinae (Spirochaeta), 1858 gallınarum (Bacillus), 520, 530 gallinarum (Bacterium), 520 gallinarum (Borrelia), 1058 gallinarum (Corynebacterium), 403 gallinarum (Grahamella), 1110 gallinarum (Hemophilus), 589 gallinarum (Listerella), 409 gallinarum (Salmonella), 492, 493, 498, 520, 521, 1135, 1136, 1137

520, 521, 1135, 1136, 1137
gallmarum (Shipella), 520
gallmarum (Spirochaeta), 1038
gallmarum (Spirochaeta), 1038
gallmarum (Triponema), 1033
gallinarum (Tritur), 1283
gallinarum var. duisbury (Salmonella),
521

521 gallinarum var. hereditaria (Spirochaela), 1653

Gallionella, 12, 17, 35, 831, 832 galophilum (Achromobacter), 424 galtieri (Bacillus), 657 gaminura (Salmonella), 529 gamina (Bacillus), 678 gamma (Bocterium), 678 cammori (Baeterium), 678 gangliforme (Bocterium), 744 gangliformis (Bacillus), 744 gongraence (Bacillus), 744, 814 congroence corcinomatosae (Spirochaeta) concraence vulpae (Bocillus), 744 gangraenosa nosocomialis (Spirochaeta), gangroenosa nosocomiolis (Treponema), 1007 congrenge emphysematosae (Bocillus), 776 gongr. ovium (Micrococcus), 267 gangrenge pulmonaris (Streptobacillus) canarenosus (Ascococcus), 250 gardeniae (Phylomonas), 136 gardeniae (Pseudomonas), 136 gardneri (Nocardia), 914 oardners (Progetinomuces), 914 garlens (Aetsnomyces), 075 onelens (Discomuces), 975 garteni (Nocardia), 975 porteni (Oospora), 975 gosoformans (Achromobacter), 421 gosoformans (Bacillus), 421, 657, 745 gosoformans (Bacterium), 421 gasoformans (Pseudomonas), 147 gasoformans (Sarcina), 201 (Bacgasoformans non liquesaciens tertum), 657 gaeogrnes (Bacillus), 812 gasogenes atcalescens anaerobius (Vicrococcus), 303 oastrica (Escherichia), 451 gastricus (Bacillus), 451, 669 gastrochaenae (Christispira), 1056 castrochoenge (Spirochaeta), 1056 Gartrococcus, 326 pastromycosis ovis (Bacillus), 775 gastrophilum (Bacterium), 352 gastrophilus (Bocillus), 352 ontune (Salmonella), 515 gauduekeau (Vibrio), 201

gryonii (Bacterium), 360

gryonii (Lactobacillus), 300

gaytoni (Bacillus), 657 gazogenes (Bocillus), 612 pazpaenes (Micrococcus), 303 gazogenes (Plectridium), 812 gazogenes (Veillonella), 303, 304 gazogenes narpus (Bocillus), 812, 827 gazogenes var gingivalis (Veillonella). 304 gazogenes var. minutissima (Veillonella). gazogenes var syzygios (Veillonella), 304 gedanensis (Actinomyces), 970 gedanensis (Discomuces), 970 gedanensis (Nocardia), 970 gedanensis (Streptothrix), 970 gedanenzis I (Streptothrix), 931, 070 Relatica (Pseudomonas), 107 gelaticum (Bacterium), 107 oclaticus (Actinomyces), 952 gelaticus (Bacillus), 107 gelaticus (Streptomyces), 952 gelatinogenus (Micrococcus), 262, 348 gelatinosa (Lamprocystis), 846 gelatinosa (Rhodocystis), 804 gelatinosa (Rhodopseudomonas), 864 gelatinosa (Thiosphoera), 816 gelatinosa (Thiothece), 816 gelatinosum (Clostridium), 762 gelatinosum betae (Bacterium), 657, 745 gelatinosus (Bacillus), 657, 745 gelatinosus (Micrococcus), 262 gelatinosus (Streptothriz), 977 gelatinum (Flarobacterium), 411 gelatogenes (Bacitlus), 657 pelechiae, No 1, No 2 and No 5 (Bacterrum), G78 gelida (Cellulomonas), 622 gelidus (Bacillus), 622 geminum (Achromobacter), 421 peminus major (Boeillus), 126 peminus major (Bacterium), 426 peminus minor (Bacellus), 421 pemenus minor (Bacterium), 421 germiforme (Bacterium), 678 genesis (Actinomyces), 920 penesis (Nocardia), 920, 960 graiculata (Pseudomonas), 93, 694

geniculatum (Achromobacter), 99
geniculatum (Baclerium), 745
geniculatus (Bacillus), 90, 903, 709, 745
geniculatus (Bacterium), 693
geniculatus (Tyrothriz), 745
genitalis (Girochacta), 1072
genitalis (Treponema), 1072
genitalium (Encapsulatus), 459

1017 geranii (Phytomonas), 166 geranii (Xanthomonas), 166 gerbill: (Grahamella), 1110 gerbilli (Grahamia), 1110 gerbilli (Listerella), 400 geton (Bacıllus), 657 ghinda (Microspira), 201 ghinda (Vibrio), 201 ghani (Clostridium), 820 giardi (Bacterium), 635 giardi (Photobacterium), 635 gibbansi (Neisseria), 301 gibbosum (Bactertum), 678 gibsoni (Bacıllus), 690 mbsons (Coccobacillus), 690 gibsonii (Actinomyccs), 963, 970 gibsonii (Streptomyces), 033 gigantea (Beggiatoa), 991, 992, 995 gigantea (Leptothrix), 366 gigantea (Leptotrichia), 366 gigantea (Neisseria), 301 gigantea (Rasmussenia), 366 gigantea (Sarcina), 291 gigantea (Spirochaeta), 1053 giganteum (Bacterium), 760 giganteum (Clostridium), 820 arganteum (Rhodospiriltum), 867 giganteum (Spirittum), 216, 217, 1053 giganteus (Flexibacter), 38 giganteus (Streptococcus), 340 giganteus lactis (Micrococcus), 232 giganteus urethrae (Streptococcus), 310 gigas (Achromatium), 998, 999 gigas (Bacıllus), 657, 745, 778, 825

gigas (Clostridium), 778 gigas (Metallacter), 745 gigas (Micrococcus), 262 gigas (Spirobacillus), 218 gigas (Streptobacteria), 745 gigas-pericardii (Streptobacteria), 745 gilva (Cellulomonas), 620 gilrus (Bacillus), 620 gilvus (Micrococvus), 262, 277 gingirae (Bacillus ?), 657 gingivae (Micrococcus), 262 . . gingivae (Streptococcus), 340 gingivae pyogenes (Bacillus), 678 gingivae pyogenes (Bacterium), 657, 678 gingivae pyogenes (Micrococcus), 262 gingiralis (Micrococcus), 301 gingivalis (Molitor), 1213 gingivitidis (Bacıllus), 678 gingirilidis (Bacterium), 678 ginglymus (Bacillus), 745 gingreardi (Micrococcus), 262 gintottensis (Bacillus), 537 gintottensis (Castellanus), 537 gintuttensis (Lankoides), 537 gintottensis (Shigella), 537 giumai (Bacillus), 544 giumai (Bacterium), 544 giumai (Salmonella), 544 giumai (Shigella), 544 giumai (Wesenbergus), 544 give (Salmonella), 522 glacialis (Bacillus), 612 glaciformis (Bacillus), 745 gladioli (Bacterium), 130 gladioli (Phytomonas), 130 gladioli (Pseudomonas), 130 glanders bacillus, 555 glandulae (Corynebacterium), 403, 404 glandulosus (Micrococcus), 262 glasser (Bacillus), 509 glauca (Nocardia), 980 glaucescens (Bacterium), 760 gladeus (Actinomyces), 980 glaucus (Bacıllus), 657 glaucus (Bacterium), 657 gliscrogenum (Bacterium), 678 gliscrogenus (Bacillus), 678

glis glis (Bartonella), 1108 alis alis (Haemobartonella), 1103 globerula (Nocardia), 903 globerulum (Mycobacterium), 903 globerulus (Proactinomuces), 903 globifer (Bacillus), 745 alabiforme (Achromobacier), 403 globiforme (Bacterium), 407, 408 globigii (Bacillus), 710, 711 globosa (Micromonospora), 979 alobasum (Promonibacterium), 379 globosus (Bacillus), 657 alobosus (Micrococcus), 262 globulosa (Cutophaga), 1049 olobulosus (Bacıllus), 657 Glocolila, 831 glomerala (Gallionella), 832 glomerata (Sideromyces), 986 glossinae (Borrelia), 1062 glossings (Enlomospira), 1062 alossinae (Spiritlum), 1062 plossinge (Spirochaeta), 1062 glossinae (Spironema), 1063 glossinae (Spiroschaudinnia), 1062 alossinae (Treponema), 1062 glostrup (Salmonella), 514 gluconicum (Acetobacter), 189 gluconicum (Bacterium), 189, 682 Gluconoacetobacter, 180 Gluconobacter, 180 glutinis (Bacillus), 745 glutinosa (Microspira), 637 alutinosa (Ristella), 577 alutinosum (Bactersum), 760 glutinosum (Photobactersum), 637 oluitnosus (Bactilus), 577 glutinosus (Bacteroides), 577 glycerinaceus (Streptococcus), 325 glycinea (Phytomonas), 131 glycinea (Pseudomonas), 131, 135 glycinea var. japonica (Phylomonas), 132 glycinea var. japonica (Pseudomonas). 131 glycines (Bacterium), 161 glycines (Phytomonas), 161

glycines (Pseudomonas), 161

olucineum (Bacterium), 131

olycineum var. japonicum (Baclerium), 137 alucinophilus (Bacillus), 745 alucinophilus (Diplococcus), 694 alucologenes (Citrobacter), 449 gobii (Chromatium), 858 goensus (Actinomyces), 975 goensis (Nocatdia), 975 goelfingen (Salmonella), 520 gonadiformis (Actinomyces), 579 gonatodes (Bacillus), 745 gondi (Spirochaeta), 1064 gondii (Spirillum), 1064 gonidiaformans (Bucillus), 579' gonidioformans (Bacteroides), 579 genidiaformans (Spherophorus), 579 goniosporus (Bacillus), 716 gonnermannı (Bacillus), 657 gonnermanni (Bacterium), 678 Gonococcus, 295, 296 gonococcus (Micrococcus), 296 gonorrhogae (Diplococcus), 298 gonorrhoeas (Merismopedia), 296 gonorrhoeae (Micrococcus), 296 gonorrhoeae (Neisseria), 296, 1298 goodstrii (Merismopedia), 288 gorini (Mammococcus), 695 gortynae (Bacıllus), 657 gossypu (Ruga), 1218 gossypina (Bacıllus), 745 gougerot: (Actinomyces), 934, 947 gougeroti (Streptomyces), 947 gracile (Buclerium), 362, 727 gracile (Chromatium), 858 gracile (Microsporon), 919 gracile (Rhabdochromatium), 854 gracile (Rhodospirillum), 867 gracile (Treponema), 1070 graculescens (Bacillus), 657 gracilezcens (Bacterium), 679 graciliar (Bacillus), 658 gracilipes (Chondromyces), 1035 gracilipes (Podangium), 1035 gracilis (Aclinomyces), 970 graciles (Bacellus), 657, 727 graculis (Lactobacillus), 362 gracilie (Monas), 854

gracilis (Pseudomonas), 147 gracilis (Rhabdomonas), 854 gracilis (Spirochaeta), 1070, 1076 gracilis (Streptobacillus), 581 gracilis (Streptococcus), 326 gracilis aerobiens (Bacillus), 653 gracilis anaerobiescens (Bacillus), 658 gracilis cadaveris (Bacillus), 658, 685 gracilis cadaveris (Bacterium), 658 gracilis ethylicus (Bacillus), 367, 814 gracilis putidus (Bacillus), 575 gracillimum (Bacterium), 679 Graciloides, 10 Graham sp., 1110 Grahamella, 37, 1100, 1109 Grahamella sp., 1109, 1110 Grahamia, 1109 graminarium (Nocardia), 970 graminarium (Streptothrix), 970 graminea (Spirochaela), 1053 graminea marina (Spirochaeta), 1053 graminearum (Actinomyces), 970 graminearum (Streptothrix), 931 gramınıs (Actinomyces), 970, 971 graminis (Marmor), 1192 graminis (Mycobacterium), 883, 890 grandis (Bacillus), 658 grandis (Fusiformis), 694 grandis (Gaffkya), 284 grandis (Saprospira), 1054 granii (Achromobacter), 199 granii (Bacterium), 199 granii (Vibrio), 199 granula (Amoebobacter), 850 granularis (Bacıllus), 745 granulata (Pseudomonas), 147 granulatum (Bacterium), 679, 718 granulatum (Thiospirillum), 212 granulatus (Bacillus), 658, 814 granulatus (Micrococcus), 256, 263, 277 granulatus (Streptococcus), 340 granuliformans (Bacterium), 595 granuliformans (Dialister), 595 Granulobacillus, 763 Granulobacıllus sp., 822 Granulobacter, 763

granulobacter pectinororum (Bacillus). granulomatis (Calymmatobacterium), 459 granulomatis (Donovania), 559 granulomatis (Klebsiella), 459 granulomatis maligni (Corynebacterium), granulosa (Spironema), 1059 granulosa (Spiroschaudinnia), 1059 granulosa penetrans (Spirochaeta), 1059 granulosis (Bacterium), 593 granulosis (Noguchia), 593 granulosum (Bacterium), 362, 679, 693, 745 granulosum (Corynebacterium), 388, 404 granulosum (Plocamobacterium), 693 granulosus (Bacillus), 658, 745, 814 granulosus (Micrococcus), 623 graphitosis (Bacıllus), 757 grassi (Treponema), 1070 grassii (Entomospira), 1070 grassii (Spirochaeta), 1009 grave (Lactobacterium), 363 oraveolens (Bacillus), 42, 658, 714 graveolens (Bacterium), 658 graveolens (Pseudomonas), 179 grawitzis (Bacillus), 401, 658 grawitzii (Bacterium), 401, 658 grigoroffi (Micrococcus), 247 grippo-typhosa (Leptospira), 1078 griseoflavus (Actinomyces), 948, 975 griscoflavus (Streptomyces), 948 griscolus (Actinomyces), 938 griseolus (Streptomyces), 938 griseum (Bacterium), 263 griseus (Actinomyc '), 948, 977 griseus (Bacıllus) 658, 695 griseus (Micrococ :his), 263, 695 griseus (Staphylococcus), 282 griseus (Streptomyces), 948 griseus radiatus (Staphylococcus), 282 groningensis (Nitrosomonas), 76 grossa (Microspira), 201 grossus (Bacillus), 745 grossus (Micrococcus), 263 grassus (Vibrio), 201 grotenfeldtii (Bacterium), 447 grolenfeltii (Streptococcus), 321

Maximum temperature 38.5 G. Minimum below 0°C. (Mushin).

Limits of growth in broth are pH 4.4 to pH 9.5 (Mushin).

Aerobic.

Source: Isolated from vascular and parenchymatic disease of stocks. Motthiola incana var. annua.

Habitat: Pathogenic on stocks

Nore: Burkholder (Phytopath., 28, 1938, 936) and Santarelli (Rev. dt Pat Veg., 29, 1939, 364) consider this species a synonym of Pseudomonas suringae. Adam and Pugsley (Jour Dept. Agric Victoria, \$2, 1934, 306) give n description of a green fluorescent pathogen on stocks which is similar to Pseudomonas syringge. Mushin (loc. cut.) considers Pseudomonna motthiolas to be n distinct apecina.

88. Pseudomonas mors-prunotum Wormald, Gour. Pom and Hort, Ser, 8, 1931, 251; Phytomonas mors-prunorum Wormald, Trans. Brit. Mycol. Soc , 17, 1932, 169; Bacterium mors-prunorum, ibid.) From L. mors, death, prunus,

plums. Rods: Motile with a polar flagellum. Gram-positive (1931) Gram-negative (1932).

Note: Possibly a green fluorescent organism since it produces a faint yellow

rolor in Uschinsky's solution Gelatin: Liquefaction.

Agar rolonies: White.

Broth plus 5 per cent sucrose: White and cloudy.

Nitrites not produced from nitrates Acid but not gas from glucose, lactose. sucrose and giveerol

Starch not hydrolyzed

Strict scrobe.

Distinctive characters: Differs from Pseudomonas prunicola (Pseudomonas springge) in that it produces a white cloudy growth in broth plus 5 per cent sucrose; a rapid acid production in nutrient agar plus 5 per cent sucrose, and a faint yellow or no color in Uschinsly's galution.

Source: Isolated from cankers on plum trees in England.

Habitat: Pathogenic on Prunus spp.

89. Pseudomonas rimaefaciens Konine. (Chron. Bot., 4, 1938, 11; Meded. Phytop. Labor, Willie Comm. Scholt., 14, 1938, 21.) From L. rima, fissure: faciens, producing.

Rods: 06 to 2.4 microns in length. Motile with 1 to 3 polar flagella. Gramnegative.

Yellow-green fluorescent water-soluble pigment produced in culture.

Gelatin: Liquified.

Agar colonies: Round, convex, smooth, somewhat granular with hyaling edge. Broth Turbid, Surface growth with

a sediment in a few days. Milk: Alkaline and clears.

Natrites not produced from nitrates Peptone, asparagin, urca, gelatin, nltrates and ammonia salts are sources of

nitrogen Hydrogen sulfide not produced.

Indole production slight.

Growth with the following carbon sources plus NO, glucose, sucrose, giveerol, succinates, malates, citmtes and ovalates. Less growth with mannitol. fructose, galactose, lactose, salicylate Acid is produced from the sugara No growth with dextrin, inulin, maltone, lactore, rhampose, salicin, tartrates, acetates, formates.

Starch not hydrolyzed.

Aerobic

Optimum temperature 25°C. Maximum about 37°C. Very slow growth at 14°G. Thermal death point 42° to 45°C. Source: Strains of the pathogen 180-

ated from poplar cankers in France and in the Netherlands.

Habitat: Pathocenic on Populus bra-

bantica, P. trichocarpa and P. candicans, This may be Pseudomonas seringae since the characters are the same and both prevnisms can infect Impatiens an. Pseudomonas syringae infects poplars (Elliott, Bacterial Plant Pathogens, 1930, 218).

halobium (Bacterium), 422 halobium (Flavobacterium) (Halobacterium), 442 halobius ruber (Bacillus), 422 halohydrium (Flavobacterium), 431 halohydrocarbonaclasticus (Desulfovibrio), 209 halonitrificans (Vibrio), 702 halophilica (Bacterium), 110 halophilica (Spirochaeta), 110 halophilum (Achromobacter), 424 halophilum (Flavobacterium), 441 halophilus (Bacıllus), 653 halophilus (Bacterium), 658 halophilus (Micrococcus), 263 halophilus (Pediococcus), 250 haloplanktis (Vibria), 703 halozeptica (Ristella), 575 halasepticum (Bacterium), 575 halosmaphila (Ristella), 576 halasmankilus (Bacteroides). 576 halotrichis (Actinomyces), 970 halstedii (Actinamyces), 953 halstedni (Streptomyces), 953 hamaquchae (Sarcina), 202 hansenianum (Bactersum), 181 haras (Bacillus), 745 harrisonis (Bacillus), 694 harrisonii (Flavobacterium), 434, 691 hartford (Salmonella), 511 hartlebiz (Achromobacter), 424 hartlebri (Bacıllus), 424 harilebis (Bacterium), 424 hartmannı (Spirochaeta), 1074 hartmanni (Spironema), 1074 hartmanni (Treponema), 1074 hartwigi (Modderula), 999 harveyi (Achromobacter), 110 harveyi (Pseudomonas), 110 hastiforme (Clostridium), 765 hastriis (Bacillus), 583 hastilis (Mycobacterium), 583 haumani (Bacillus), 814 haumanni (Bacillus), 814 haumanni (Clostridium), 814 hauseri (Diplococcus), 263

hauseri (Micrococcus), 263

harana (Salmonella), 527 haraniensis (Bacillu-), 658 havaniensis (Bacillus) (Micrococcust), 918 havaniensis (Bacterium), 918 havaniensis (Serratia), 918 haraniensis (Streptococcus), 310 havaniensis liquefaciens (Bacillus), 658 havaniensis liquefaciens (Bacterium), 658 Haverhillia, 38, 588, 972 hayducki (Bacilius), \$59, 693 hayducki (Plocamobacterium), 693 hayduckii (Lactobacillus), 359 beali (Bacterium), 604 healii (Achromobacter), 604 healii (Escherichia), 604 hebdomadis (Leptospira), 1077, 1078, hebdomadis (Spirochaeta), 1077 hebdomadıs (Spiroschaudinnia), 1077 hebdomadie (Treponema), 1077 hebetisiceus (Bacterium), 679 hederae (Bacterium), 168 hederae (Phytomonas), 166 hederae (Nanthomonas), 166 hegneri (Grahamelia), 1110 heaneri (Grakamia), 1110 heidelberg (Salmonella), 504 heimi (Actinomyces), 936, 970 heleogenes (Microspira), 201 heleogenes (Vibrio), 201 helgolandica (Cristispira), 1058 helianthi (Bacterium), 141 helianthi (Phytomonas), 141 helianthi (Pseudomonas), 141 helianthi var. tuberosi (Phytomonas), 141 Helicabacterium), 690 helicoides (Bacillus), 690 Helicanema, 1057, 1069 helminthoides (Bacillus), 368 helminthardes (Catenabacterium), 363 helveticum (Plocamobacterium), 695 helveticum (Thermobacterium), 352 helveticus (Lactobacillus), 352, 695 helvolum (Bactersum), 395 helvolum (Corynebacterium), 393, 395, 407

gruberi (Actinomyces), 970 gruberi (Bacıllus), 771 grubers (Nocardia), 970 gruberi (Oospora), 970 gruebers (Streptothrix), 970 oruenthali (Bacıllus), 451 gruenthali (Bacterium), 451 gruenthal: (Escherichia), 451 grumpensis (Salmonella), 527 grallotalnae (Bacallus), 745 grullotalpae (Bacterium), 679 guano (Bacillus), 745 quequent (Actinomyces), 922 guequeni (Discomyces), 922 guegueni (Nocardia), 922 guignardi (Aclinomyces), 970 autanardi (Oospora), 934, 970 guillebeau a, b, and c (Bacillus), 457 guilliermondu (Oscillospira), 1001 gulosus (Bacteroides), 573, 579 aulosus (Sphaerophorus), 573, 579 gummıs (Bacıllus), 145, 466 oummis (Bacterium), 145 oummisudans (Baclerium), 167 gummisudans (Phytomonas), 167 gummieudans (Pseudomonas), 167 gummisudans (Xanthomonas), 167 gummosum (Bacterium), 679, 745 gummosus (Bacıllus), 679, 745 gummosus (Micrococcus), 262, 263, 343, gunther: (Baeillus), 326 gunthers (Bactersum), 323

973
guithers (Baeillus), 329
günthers (Bacterium), 323
günthers (Steptoeccus), 324
guita cerei (Pneumococcus), 697
guitatum (Actomobacter), 421
guitatum (Steptium), 424
guitatus (Stertium), 424
guitatus (Stertium), 424
guitatus (Stertium), 425
guptoides (Actinomyces), 697

The Physical age (607)

habanensis (Siaphylococcus), 282
hacharsae (Spirillum), 217
hacharsae (Spirochaeta), 217
hacharsae (Spirochaeta), 217
hacharsae (Treponema), 217
hachariseum (Spirillum), 217
hackati (Pedioplana), 250
haemalodes (Micrococcus), 263
haemalosey (Siaphylococcus), 263
haemalosey (Sactrilus), 658
haemalosey (Sactrilus), 658
haemalosey (Micrococcus), 272
Haemobartonella, 1102, 1107, 1108
Haemobartonella, 1102, 1107, 1108
haemoglobiophylla sporulens (Leptothriz), 366
haemoglobiophylla sporulens (Leptothriz), 366
haemoglobiophylla (Bactrium), 587

haemoglobsnuriae (Leptospira), 1078 haemoglobsnuriae (Spirachaeta), 1078 haemoglobsnuriae (Spirachaeta), 1078 haemoglobsnus (Clostridium), 820 Haemophilus (Tyrochaeta), 1067 haemophilus (Spirachaeta), 1067 haemophilus (Spirachaeta), 1067 haemorrhagicum (Baelerium), 532 haemorrhagicus (Bacollus), 532 haemorrhagicus (Micrococcus), 263

haemoglobinophilus (Hemophilus), 585,

haemorrhagicus (Staphylococcus), 263 haemorrhagicus nephriidis (Bacillus), 553 haemorrhagicus nephriidis (Baclerium), 553

haemorrhagicus septicus (Bacillus), 552 hacmorrhagicus septicus (Bacilerum), 553 haemorrhagicus telenosus (Bacillus), 553 haemorrhagicus velenosus (Bacterum), 553

hajeki (Bacıllus), 658 halans (Bacıllus), 679 halans (Bacıllus), 679 halensis (Micrococcus), 203 halestorgus (Pscudomonas), 147 halatus (Streptococcus), 310 halmephilum (Flarobacterium), 411

haemotosaprus (Streptococcus), 340

Halobacterium, 412 halobieus (Bacillus), 658 halobieus desulfuricans (Vibrio), 201

histolyticum (Clostridium), 811 histolyticus (Bacillus), 811 histolyticus (Weinbergillus), 811 histotropicus (Musculomyces), 1293 hoagii (Bacillus), 387 hoagii (Corynebacterium), 387 hodgkini (Bacillus), 404 hodgkini (Fusiformis), 404, 583 hodgkinii (Corynebacterium), 404hoffmanii (Bacillus), 385, 659 hoffmanii (Corynebacterium), 395 hoffmanni (Actinomyces), 971, 976 hoffmanni (Cladothrix), 971, 976 hofmanni (Micramyces), 971, 976 hoffmanni (Nocardia), 976 hoffmanni (Oospora), 971, 976 hofmanni (Streptothrix), 971, 976 holci (Bacterium), 120 holci (Phytomonas), 120 holci (Pseudomonas), 120 holcicola (Bacterium), 157 holcicola (Phytomonas), 157 holcicola (Pseudomonas), 157 holcicola (Xanthomonas), 157 hollandiae (Photobacter), 636 hollandicum (Photobacter), 636 hollandicum parvum (Photobacter), 636 hollandicus (Bacillus), 746 hollandicus (Streptococcus), 325 holmesi (Actinomyces), 971 holmesi (Discomyces), 971 holobutyricus (Bacıllus), 771, 824 holodise: (Nanus), 1207 Holospora, 1122 holsatiensis (Salmonella), 531 hominis (Actimomyces), 916, 971 hominis (Corynethrix), 406 hominis (Discomyces), 916 hominis (Leuconostoc), 308 hominis (Listerella), 409 hominis (Molitor), 1241 hominis (Nocardia), 916, 920 hominis (Oospora), 920, 922 hominis (Proteus), 691 (Streptothrix), 896, 920, 923, hominis 976

hominis I (Streptothrix), 920

hominis II (Streptothrix), 921 hominis III (Streptothrix), 922 hominis IV (Streptothrix), 922 hominis (Strongyloplasma), 1241 hominis capsulatus (Bacterium), 691 hominis capsulatus (Proteus), 691, 816 haplosternus (Bacillus), 717, 746, 759 hormaechei (Salmonella), 529 hornensis (Streptococcus), 348 horton (Actinomyces), 962 hortonensis (Streptomyces), 962 hoshigaki (Acetobacter), 183, 184 hoshigaki (Bacterium), 184 hoshigaki var. glucuronicum (Bacterium), 184, 679 hoshigaki var. glucuronicum I (Bacterium), 491 hoshigaki var. rosea (Bacterium), 183, Hostis, 1239 hudsonii (Bacıllus), 650 hudsonii (Bacterium), 659 hueppei (Bacillus), 740 hueppei (Clostridium), 740 hueppi (Bacıllus), 820 hueppi (Clostridium), 820 humicola (Pseudomonas), 698 humidus (Micrococcus), 263 humifica (Streptothrix), 977 humilis (Bacillus), 659 humosus (Bacıllus), 771 humuli (Chlorogenus), 1151 hutchinsonii (Cytophaga), 1012, 1013, 1016, 1049 hvittingfoss (Salmonella), 528 hyacinthi (Bacillus), 152, 470 hyacinthi (Bacterium), 152 hyacinthi (Phytomonas), 152 hyacinthi (Pseudomonas), 152 hyacinthi (Xanthomonas), 152, 178 hyacinthi septica (Erwinia), 470 hyacinthi septicus (Bacillus), 470 hyacınthi septicus (Bacterium), 470. hyalina (Chlamydothrix), 986 hyalina (Lampropedia), 844 hyalina (Leptothrix), 986 hyalina (Macromonas), 1001



iliacus (Escherichia), 451 iliacus (Proteus), 451 ilidzense (Bacterium), 760 ılidzense capsulatus (Bacillus), 760 illini (Miyagawanella), 1119 illinois (Salmonella), 525 imetrofa (Zaogalactina), 479 imetrophus (Bacillus), 480 imetrophus (Protococcus), 479 immınutus (Bacillus), 746 immobile (Bacterium), 98 immobilis (Acuformis), 813 ımmobilis (Bacillus), 746 immobilis (Granulobacter), 790 immobilis (Palmula), 813 ummobilis-liquefaciens (Butyribacillus), 790 immotum (Bacterium), 606 imomarinus (Bacıllus), 748 imperatoris (Micrococcus), 264 imperiale (Bacterium), 608 implectans (Bacterium), 760 implexum (Bacterium), 718 implexus (Bacillus), 718 inaequale (Treponema), 1062 inacqualis (Bacteroides), 568, 579 inaequalis (Spherophorus), 563, 579 inaequalis (Spirochaeta), 1062 incana (Sarcina), 292 incanae (Phytomonas), 158 incanae (Xanthomonas), 158 incanescens (Actinomyces), 971 incannum (Bacteri ım), 659 incanus (Bacıllus), 659 incanus (Bactersum), 659 incarnata (Sarcina), 292 incarnatus (Rhodococcus), 292 incertum (Bacterium), 607 incertum (Plectridium), 794 incognita (Pseudomonas), 95, 147, 698 incognitus (Erro), 1250 incommunis (Bacteroides), 570, 575 inco nmunis (Ristella), 570, 575 inconspicuus (Micrococcus), 264 inconstans (Tetrachloris), 870 indica (Nocardia), 909, 960

indica (Oospora), 909

indica (Serratia), 481, 701 indicens (Phagus), 1137 indicum (Azotobacter), 221 indicum (Bacterium), 701 indicum (Chromobacterium), 481 indicum (Leuconostoc), 346 indicum (Photobacter), 700 indicum (Photobacterium), 111, 634, 636 indicum var. obscurum (Photobacter), indicum var. parvum (Photobacter), 700 indicus (Actinomyces), 909 indicus (Bacillus), 481, 700 indicus (Discomuces), 909 indicus (Erythrobacillus), 481 indicus (Micrococcus), 481 indicus (Vibrio), 69) indicus obscurus (Bacillus), 700 indicus parvus (Bacıllus), 700 indicus ruber (Bacillus), 481, 701 indicus semiobscurus (Bacillus), 700 Indiella, 966 Indiellopsis, 966 indifferent (Bacillus), 748 indigoferus (Bacillus), 697, 698 indigoferus (Bacterium), 698 indigoferus (Pseudomonas), 699 indigoferus var. immobilis (Pecudomonus), 693 indigogenus (Bacillus), 639 indigogenus (Bacterium), 659 indigonaceum (Bacterium), 697, 698 andigonaceus (Bacillus), 697 indivisum (Polyangium), 1031 indolicus (Bacillus), 814 indolicus (Inflabilis), S14 indolicus (Micrococcus), 217, 264 Indolococcus, 235 indologenes (Aerobacter), 457 indolozidans (Pseudomonas), 608 indomitus (Phagus), 1133 industrium (Acetobacter), 185 industrium (Bacterium), 186 andustrium var. hoshigaki (Bacterium), 184, 694 industrius (Bacillus), 186 ineptus (Phagus), 1138

hualina (Merismopedia), 844 hyalina (Pseudomonas), 907, 1001 hyalina (Sarcina), 844 hualina (Streptothrit), 986 hyalinum (Achromobacter), 424 hyalinum (Clostridium), 820 hyalınım (Gonium), 844 hualinum (Mucobacterium), 890 hyalinus (Bacillus), 424 hyalinus (Bacterium), 424 huglinus (Micrococcus), 844 hyalinus (Pediococcus), 844 Hualococcus, 305 hudrocharis (Bacillus), 659 Hudrocoleus, 993 hydrogenicus (Omelianskillus), 809 hydrogenii (Bacillus), 809 Hydrogenomonas, 20, 76 hudrophila (Aeromonas), 102 hydrophila (Pseudomonas), 102 hudrophilum (Bacterium), 102 hydrophilus (Bacillus), 102 hudrophilus (Proleus), 102 hydrophilus fusçus (Bacillus), 102 hydrophilus fuscus (Baclerium), 102 hydrophobia (Neuroryctes), 1264 hydrophoborum (Streptococcus), 340 hydrosulfurea (Pseudomonas), 147 hydrosulfureum ponticum (Bacterium). hydrosulfureus (Bacillus), 659

hydrothermicus (Micrococcus), 264 Hugrocrocis, 1003 hygroscopicus (Actinomyces), 953 hygroscopicus (Streptomyces), 953 hymenophagus (Micrococcus), 264 hyochi (Lactobacıllus), 363 hyochi var. 1 (Lactobacillus), 363 hyochi var. 2 (Lactobacıllus), 363 hyopyogenes (Bacterium), 388 hyos (Borrelia), 1063 hyos (Spirochaeta), 1063 hyos (Spironema), 1063 hyos (Vibrio), 201 hyoscyami (Marmor), 1171 hypertrophicans (Corynebacterium), 398 hypertrophicans (Phytomonas), 398

hypertrophicans (Pseudomonas), 398 hypertrophicus (Caryococcus), 1121 hyphalus (Vehro), 703 Hyphomicrobium, 35, 837 Hypnococcus, 312 hypothermis (Pseudomonas), 698

ianthina (Pseudomonas), 232 ianthinum (Bacteridium), 232 ianthinum (Bacterium), 231, 232 ianthinum (Chromobacterium), 232, 234 ichthyismi (Bacillus), 814 ichthyodermis (Achromobacter), 108 ichthyodermis (Pseudomonas), 108 echthyosmia (Escherichia), 103 ichthyosmia (Pseudomonas), 103 ichthyosmius (Bacıllus), 103 ichthuosmus (Proteus), 103 icterogenes (Bacillus), 659 icterogenes (Bacterium), 659 icterogenes (Leptospira), 1077 icterogenes (Spirochaete), 1076 sclerogenes (Treponema), 1076 sclerogenes marina (Spirochaeta), 1053 sciero-haemorragiae (Treponema), 1078 icterohaemorrhagiae (Leptospira), 90, 1076, 1077, 1078, 1079

1076, 1077, 1078, 1079
seterohaemorrhagiae (Spirochaeta), 1076
seterohaemorrhagiae (Spiroschaudinnia),
1076

icteroides (Bacterum), 531
reteroides (Leptospiro), 1079
seteroides (Samonella), 531
seteroides (Samonella), 531
seteroides (Sprinchaeta), 1079
seteroides (Terponema), 1079
seteroides (Terponema), 1079
seteroides (Terponema), 1079
seteroides (Terponema), 1079
seteroides (Callomomos), 613
idoneutin (Bacterium), 613
idoneutin (Bacterium), 613
idoneutin (Bacterium), 613
idoneutin (Bacterium), 323
ikterane (Cocodocallus), 536
ikterane (Cocodocallus), 636
ikterane (Cocodocallus), 636
ikterane (Cocodocallus), 636

interrogans (Treponema), 1079 interrogationis (Cristispira), 1056 intertriginis (Micrococcus), 264 intestinale (Bacteriophagum), 1128 intestinale (Thermobacterium), 352 intestinale (Treponema), 1067 intestinale suis (Bacterium), 503 intestinalis (Arthromitus), 1003 intestinalis (Bacillus), 654 intestinalis (Bifidibacterium), 369 intestinalis (Cladothrix), 983 intestinalis (Hygrocrocis), 1003 intestinalis (Sarcina), 292 intestinalis (Spirochaeta), 1067 intestinalis tuberculiformis (Bacillus), intestinus motilis (Bacillus), 659

intestinus motilis (Bacterium), 659 intracellularis (Diplococcus), 296, 297, (Meningococcus), 297 301 intracellularis (Micrococcus), 297 intracellularis intracellularis (Neisseria), 297 intracellularis (Streptococcus), 296, 297 296, 301 (Tetracoccus), intracellularis meningitidis (Diplokokintracellularis

(Microkus), 296 meningitidis intracellularis intracellularis-meningitidis (Neisseria),

intrapallans (Bacıllus), 746 intricata (Cladothrix), 718 intricatus (Bacillus), 718 intrinsectum (Bacterium), 769 intybi (Bacterrum), 125 ıntybi (Phytomonas), 125 intybi (Pseudonomas), 125, 131 inulinaceus (Streptocaccus), 321 inulofugus (Bacillus), 772, 824 inunctum (Achromobacter), 425 anunctus (Bacillus), 425 inunctus (Bacterium), 425 anutilis (Bacillus), 659 invadens (Caryococcus), 1120 inverness (Salmonella), 530

inverto-acetobutylicum (Clostridium), 781, invisibile (Flavobacterium), 434 invisibilis (Bacillus), 434 invisibilis (Bacterium), 431 involutus (Bacillus), 612 involutus (Diplococcus), 308 involutus (Streptococcus), 308 invulnerabilis (Actinomyces), 971 inculnerabilis (Cladothrix), 934, 971 invulnerabilis (Nocardia), 971 invulnerabilis (Streptothrix), 971 iodinum (Chromobacterium), 694 iodinum (Pseudomonas), 694 Iodococcus, 695 iodophilum (Clostridium), 772 iogenum (Bacillus), 679 iogenum (Bacterium), 251, 679 iophagum (Achromobacter), 418 iophagum (Bacterium), 418 ipomeae (Flarimacula), 1202 ipomoea (Actinomyces), 958 ipomoea (Sireptomyces), 958 iridescens (Pseudomonas), 174 iridicola (Bacterium), 140 iridicola (Phytomonas), 140 iridicola (Pseudomonss), 140 iridis (Bacterium), 147 iridis (Marmor), 1183 iridis (Phytomonas), 147 iridis (Pseudomonas), 147 iris (Bacterium), 698, 760 iris (Micrococcus), 264 1718 (Pseudomonas), 147, 698 arregularis (Bacillus), 814 irregularis (Clostridium), 814 irregularis (Micrococcus), 261 israeli (Actinobacterium), 926 israeli (Actinomyces), 365, 926 israeli (Brevistreplothrix), 926 israeli (Cohnistreptothrix), 926

israeli (Corynebacterium), 926

israeli (Proactinomyces), 926

israeli (Streptothrix), 926

ısraelı (Discomyces), 926

israeli (Nocardia), 926 israeli (Oospora), 926

iners (Marmor), 1190 iners (Vibrio), 204 inertia (Pseudomonas), 698 inexorabilis (Formido), 1263 infantilis (Bacil'us), 746 infantilism (Bacillus), 814 infantis (Salmonella), 512 infantum (Bacterium), 490 infantum (Proteus), 490 infecundum (Racterium), 679 infimus (Micrococcus), 695 Infabilis, 33, 31, 763 inflans (Rabula), 1284 infotum (Clostridium), 814 inflatus (Bacıllus), 814 in fuentiae (Streptoco:cus), 310 infuenzae (Ba illus), 585 influenzae (Bacterium), 585 influenzae (Hemophilus), 685, 596, 589,

1296
influenzar (Nicrococcus), 261
influenzar (Sireplococcus), 310
influenzac (Sireplococcus), 350
influenzaciprans (flocal us), 550
influenzaciprans (Spherophorus), 550
influenzaci murium (Bacterum), 550
influenzaci murium (Hemophilus), 550
influenzaci putoriorum multiforrec (Bac-

lenum), 550 influenage auis (Bacterium), 586 influensae suis (Hemophilus), 586 influensoides apis (Hacillus), 603 infrequens (Bacillus), 451 infrequent (Streptococcus), 310 infut onum (l'almella), 657 ingrica (Thioploca), 901 inquinalis (Encapsulatus), 459 innesi (Bacillus), 671 innocuus (liabula), 1235 innominata (Leptothris), 366 innominata (l'ieudoleptothriz), 366 incomingtum ((lostridium), 792 incomingly (Actinomices), 971 innutrita (l'e'mula), 78 innutritus (deuformis), 793 innstritus (Barillus), 798, 826 incenum (flactetium), 679 inalous (Brailius), 600

insecticola Eberthella), 534 insecticolena (Proteus), 400 insectiobilium (Bacterium), 604 insectorum (Bacillus), 264 insectorum (Coccobacillus), 600 ansectorum (Leptothriz), 366 insectorum (Micrococcus), 261 inzectorum (Staphylococcus), 282 insectorum (Streptococcus), 261 insectorum var. malacosomae (Coccobacillus), 690 insidiosa (Phytomonas), 392 inzidiosum (Aplanobacter), 392 ensidiosum (Bactersum), 332 insidiosum (Corvnebacterium), 392 ensidiosum var. saprophyticum (Corynebacterium), 393 enzidiosus (Bacellus), 411 insolita (Azotomonas), 221 inzolita (Ristella), 568, 576 insolitus (Bacteroides), 568, 576 insulosum (Bacterium), 700 insulum (Bacterium), 760 intactum (Bacterium), 760 intermedia (Microspira), 201 intermedia (Oospora), 971 intermedia (Sareins), 202 intermedia (Spirochaeta), 1075 sntermedium (Baeterium), 360 intermedium (Citrobacter), 419 intermedium (Clostridium), 771, 821 intermedium (Escherichia), 419, 460 intermedium (Lactobacillus), 360 intermedium (Paracolobactrum). 420, 431 intermedium (Treponema), 1075 enfermedius (Actinomyces), 971

internedium (Treponerus), 1005
internedius (Racillus), 701
internedius (Bacillus), 702
internedius (Bacillus), 702
internedius (Thagus), 1100
internedius (Thagus), 1100
internedius (Sirpitococcus), 331
internedius (Sirpitococcus), 331
internedius (Racillus), 746
internedius (Racillus), 746
interproximalus (Actionyrus), 971
interproximalus (Actionyrus), 971
interproximalus (Actionyrus), 971
interproximalus (Sireytothriz), 971
interproximalus (Sireytothriz), 971
interproximalus (Sireytothriz), 1079
interproximalus (Sireytothriz), 1079

kaukasicus (Bacillus), 351 kaustophilus (Bacillus), 730 kedrowskii (Bacillus), 814 kefersteinii (Micrococcus), 256 kefir (Bacıllus), 746 kefir (Streptococcus), 333, 347 kegallensis (Vibrio), 201 Lentucky (Salmonella), 526 keratolytica (Actinomyces), 916 keratolyticus (Proactinomyces), 916 keratomalaciae (Bacterium), 679 kermesinus (Bacillus), 746 khartoumensis (Bacillus), 452 khartoumensis (Enteroides), 452 khartoumensis (Escherichia), 452 kielense (Chromobacterium), 482 kildini (Bacıllus), 746 kilensis (Serratia), 482, 483 kiliense (Bacterium), 432 Liliensis, (Bacillus), 432, 434 kiliensis (Erythrobacillus), 482 kimberi (Actinomyces), 984 kimberi (Streptomyces), 964 kirchneri (Streptococcus), 340 kirkee (Salmonella), 529 Klebsiella, 10, 18, 31, 37, 443, 457, 458 klebsii (Bacillus), 659 klebsis (Helicobacterium), 690 kleckii (Bacillus), 659 kleinis (Bacıllus), 659, 660, 788 kleinis (Clostridium), 788 klimenko (Vibrio), 205 kluyversi (Clostridium), 791, 820 knipowitchi (Bacterium), 680 Kochella, 13 Lochs (Spirochaela), 1060 kochi (Treponema), 1060 kochii (Bacıllus), 877 kochii (Borrelia), 1060 kochii (Pediococcus), 250 kochii (Schlerothrix), 877 kochii (Spirillum), 1054 kochii (Spirochaele), 1054 kochti (Spironema), 1060 kochii (Streptococcus), 310 kolkwitzii (Spirillum), 217 kõin (Salmonella), 503

kornii (Bacillus), 660 kottbus (Salmonella), 513 koubassoffi (Bacillus), 746 krainskii (Actinomyces), 938 krainskii (Nocardia), 946 kralii (Bacillus), 680 kralii (Bacterium), 680 krameri (Bacillus), 477 krameriani (Bacterium), 145 krausei (Actinomyces), 971 krausei (Discomyces), 971 krausei (Nocardia), 921, 971 krausei (Streptothrix), 971 krusecastellani (Castellanus), 540 krzemieniewskae (Cytophaga), 1014 krzemieniewski (Bacıllus), 722 kuehniana (Crenothrix), 937 kuehniana (Hypheothrix), 987 kuchniana (Leptothrix), 987 kuetzingianum (Acetobacter), 180, 183 kuetzingianum (Bacterium), 183 kurlova (Ehrlichia), 1095 kurlovi (Ehrlichia) (Rickettsia), 1095 Kurthia, 21, 26, 30, 31, 808 kutscheri (Bacterium), 390 kutscheri (Corynebacterium), 389 kutscher: (Spirillum), 216 kwanzani (Rimocortius), 1200, 1210

laburni (Marmor), 1187 lacca (Bactilus), 746 lacerans (Bacillus), 639 lacerans (Carpophthora), 1152 lacerans (Marmor), 1152 lacerans (Phagus), 1139 lacertae (Actinomyces), 971 lacertae (Oospora), 971 lacertae (Streptothrix), 971 lachrymans (Bacellus), 116 lachrymans (Bacterium), 116 lackrymans (Phytomonas), 116 lachrymans (Pseudomonas), 116 lacmus (Bacillus), 233 lactantium (Bacillus), 454. lactea (Neisseria), 261 lactea (Sarcina), 292 Inetericeus (Micrococcus), 264

usracii var spitei (Actinobacterium), 925
tialica (Sainomella), 522
tialica (Pseudomonas), 147
tialicum No 1 and No. 2 (Bacterium),
760
tialicum (Marmor), 1202
Itersonia, 104
tiersonia, 104
tiersonia, 104
tiersonia, 105
tioana (Pseudomonas), 160
tioana (Pseudomonas), 160
tioana (Pseudomonas), 160
tioana (Pseudomonas), 161
tioana (Pseudomonas), 161
tioana (Pseudomonas), 161
tioana (Bacterium), 163
tioana (Gelfulomonas), 616
tioana (Tseudomonas), 616
tioana (Tseudomonas), 616
tioana (Tseudomonas), 618
tioana (Sainomella), 531
tioa (Bacillulomonas), 532
tioa (Bacillulomonas), 533
tioa (Bacillulomonas), 534
tioa

ixiae (Erwinia), 478

jaegeri (Pseudomonas), 69, 698 jaggert (Bacterium), 122 jaggeri (Phytomonas), 122 jagger: (Pseudomonas), 122 jakschie (Bacillus), 691 jakschis (Urobacillus), 691 janthina (Pseudomonas), 232 2anthinus (Bacillus), 232 japonica (Actinomyces), 916 10 ponica (Pseudomonas), 226 japonica (Spirochaeta), 215 japonica (Streptothrix), 016 japonicum (Baclerium), 226 japonicum (Propionibacterium), 379 japonicum (Rhizobacterium), 226 japonicum (Rhizobium), 62, 224, 226 japonicum (Treponema), 215 japonicus (Bacillus), 536 japonicus (Discomyces), 916 japonicus (Erro), 1250 javanense (Photobactersum), 147 javanensis (Myxococcus), 1041 javanensis (Nitrosocystis), 72 javanensis (Nitrosomonas), 62, 72 jatanensis (Pscudomonos), 72 jatanica (Pseudomonas), 147, 699 jaranicum (Photobacterium), 147 jaraniensis (Bacillus), 147 jaianiensis (Bacterium), 147, 699

reffersonsi (Bactersum), 520 1efferson: (Eberthella), 520 jeffersonis (Shigella), 520 nerunales (Bacillus), 451 jejuni (Vibrio), 201 genense (Rhodothiospirillum), 851 jenense (Spiritlum), 851 jenense (Thiospirillum), 651, 852 senense forma maxima (Thiospirillum). jenensis (Ophidiomonas), 851 jensenii (Propionibacterium), 376, 377 jensenii var raffinosaceum (Propionibacterium), 377 Jodoccus, 695 30genum (Bacterium), 679 Johnet (Ascococcus), 253 jolly: (Actinomyces), 920 jolly: (Discompces), 920 30lly: (Nocardia), 920 jolly: (Oospora), 920 jonesti (Spirochaeta), 1067 jonesii (Spironema), 1067 jongii (Micrococcus), 264 josephi (Bacillus), 592 josephi (Moraxella), 592 joyeuxii (Grahamella), 1110 jubatus (Bacillus), 746 juglandis (Bacillus), 158 juglandis (Bacterium), 158 juglandis (Phytomonas), 158 juglandız (Pseudomonas), 158 juglandry (Xanthomonas), 158, 160 jugurt (Lactobacellus), 364 jugurt (Thermobactersum), 364 kaapstad (Sulmonella), 505

javiana (Salmonella), 520, 522

kairo (Rockettra), 1096 kaleidascopicus (Bacillus), 746 kandiensi (Bacillus), 534 kandiensi (Bacillus), 534 kandiensi (Eberthila), 531 kandiensi (Eberthila), 534 kaposar (Galmonella), 505 kappa (Bacillus), 639 kauffmanni (Salmonella), 493 tive.

Pseudomonas papulans Rose. (Rose, Phytopath., 7, 1917, 198; Phytomonas papulans Bergey et al., Manual, 3rd cd., 1930, 267; Bacterium papulans Elliott, Bacterial Plant Pathogens, 1930, 175; Phytomonas syringae var. papulans Smith, Jonr. Agr Res , 68, 1911, 291.) From L. papulans, forming blisters.

Rods: 0 6 by 0 9 to 2 3 microns. Motile with I to S polar flagella Gram-nega-

Green fluore scent pigment produced in culture.

Gelatin: Liquehed

Broth. Moderate turbidity in 21 hours. Milk: Alkaline and at times a roft congulum.

Nitrates not produced from nitrates. Indole: May or may not be produced. Acid but not gas formed from glucose

and sucrose Optimim temperature 25° to 28°C. Maximum 37°C

Source Twenty five cultures isolated from blisters on apples and from rough bark.

Habitat Pathogenic on number trees.

Pseudomonas pseudozoogloeae (Honing) Stapp (Bacterium preudozooglocae Honing, Bull, vna Het, Deli Proefstation, Medan, 1, 1911, 7, Stapp, in Sorauer, Handbuch der Ptlanzenkrankheiten, 2, 5 Auf , 1928, 271; Phytomonas pseudotooglocae Bergey et al . 3rd ed , 1930, 261.) From Gr , pscudo, false; M. L. zoogloea, zooglen. Rods: 0.7 to 15 by 09 to 25 microns.

Chains. Motile with 1 or 2 polar flagella. Gram-negative.

Green fluorescent pigment produced in culture.

Gelatin Liquefaction.

Agar colonies. Round, flat, yellowgray.

Broth: Moderate turbidity with pseudozoogloen in the pellicle

Milk . Coaghlation. No clearing. Nitrites non produced from nitrates Indole not formed

Hydrogen sulfide produced

Acid but not gas from glucose, lactose, maltore, sucrose and mannitol.

l'acultative annerole.

Source: Irolated from the black rust of tobacco.

Habitat: Pathogenic on tobacco. Nicotiana Iabacum.

Pseudomonas tabaci (Wolf and l'orter) Stevens, (flacterium tabacum Wolf and Poster, Science, 46, 1917, 362; nlso Jour. Agr. Res., 12, 1918, 419; Phytorunas tabaci Bergey et nl., Manual, 1st ed., 1923, 185; Stevens, Plant Disease Fungi, New York, 1925, 31.) From Nicotiana tabacum, tolineca.

Rods: 1.2 by 3.3 microns. Motile with

a polar flagellum. Gram-negative. Gelatin: Liquefaction.

Putato agar colonics: Grayish-white, circular, raised, wet-shining, smooth,

Milk: Alkaline; clears. Nitrites not produced from nitrates.

Indole not formed.

Acid from glucose, galactose, fructose, I-ambinose, xylose, succese, pectin, mannited and giveered (Braun, Phylogath, 27, 1937, 289)

Ammonium sulfate, potassium nitrate, eystine, glutamic acid, glycine, succinimide, examide, acetamide, and urea can be used as nitrogen source (Braun).

Starch not hydrolyzed. Acrobic. Distinctive character: Braun (loc. cit.) states that Pseudomonas tabari and Pseu-

domonas angulata pre identical in culture. Source: Isolated from wildfire lesions

ou tobacco leaves in North Carolina. Habitat: Pathogenic on tolucco, Nico. tiana tabacian.

93 Pseudomonas lapsa (Ark) Burkholder. (Phytomonas lapsa Ark, Phytopath., 30, 1910, 1; Burkholder, ibid., 52, 1912, 601.) From Latin, lapsus, falling, referring to a symptom of the disease.

Rods: 0.56 by 1.55 microns. Motile with I to I polar flagella.

Produces fluorescence in Uschinsky's Fermi's, and Cohn's solutions.

lacteum (Bacterium), 738 lacteus (Bacillus), 716, 755 lacteus (Micrococcus), 264 lacteus (Streptococcus), 340 lacteus faviformis (Micrococcus), 261 lactica (Pseudomonas), 147 Inctica (Serratia), 600 lactici-acidi (Bacillus), 447 lacticola (Bacillus), 43, 716 lacticola (Bacterium), 716 lacticola (Mycobacterium), 887, 888, 889,

lacticola perrugosum (Mycobacterium),

lacticola B perrugosum (Mycobacterium). 890

lacticola planum (Mucobacterium), \$90 lacticola a planum (Mycobacterium), 890

lacticola y friburgensis (Mycobacterium),

lacticum (Achromobacter), 425 lacticum (Bacterium), 324 lacticum (Corynebacterium), 370 lacticum (Microbacterium), 353. 370,

lacticus (Bacillus), 324, 362, 447 lacticus (Micrococcus), 336 lacticus (Streptococcus), 324 lactimorbus (Bacillus), 727 lactivarcus (Bacıllus), 810 lactis (Acidobacterium), 361 lactis (Bacıllus), 660, 716, 725 lactis (Bacterium), 323, 454, 684 lactic (Chlorobacterium), 693 lactis (Flavobacterium), 434 lactis (Lactobacillus), 351 lactis (Lactococcus), 324 lactis (Micrococcus), 264 lactis II (Micrococcus), 264 lactis (Sarcina), 292

lactis (Streptococcus), 43, 323, 324, 325, 310 332 lactis B (Streptococcus), 325 lactis (Thermobacterium), 351 lactis No. 1 (Bacillus), 716, 725

lactis, No. II (Bacıllus), 741

lactis No. III lactis No. IV, lactis No. V. lactis No. VI (B

lactis No. VII lactis No. VIII lactis No IX ( lactis No. X (B

lactis No. XI (Bacutus), 743 lactis No XII (Bacillus), 755, 761 lactis acidi (Bacillus), 324, 351

lactis acidi (Bacterium), 323, 324 lactis acid: (Lactobacellus), 351 lactis acidi (Micrococcus), 264

lactis acidi (Sarcina), 292 lactis acid: (Staphylococcus), 282 lactis acrogenes (Bacillus), 454 lactis aerogenes (Bacterium), 451 lactis aerogenes (Encapsulatus), 454 lactis albidus (Micrococcus), 238

lactis album (Bacterium), 416 lactis albus (Bacillus), 716, 718, 746 lactis albus (Micrococcus), 264 lactis albus (Sarcina), 292 lactis amars (Micrococcus), 265 lactis arborescens (Micrococcus), 252

lactis aromaticus (Streptococcus), 340 lactis aurantiaea (Sarcina), 292 lactis aureus (Micrococcus), 253, 265 lactis citreus (Micrococcus), 265 lactis citronus (Micrococcus), 265 Iactis cloacae (Bacillus), 455

lactiv commune (Bacterium), 362 lactis erythrogenes (Bacillus), 600, 654 lactis erythrogenes (Bacterium), 600 tactis erythrogenes (Chromobacterium), 600

(laciss) erythrogenes (Erythrobacillus), 600 lacits erythrogenes (Micrococcus), 600

lactis flavus (Micrococcus), 265 lactis fluorescens (Micrococcus), 265 lactis foetidum (Viscobacterium), 691 lactis giganteus (Micrococcus), 235 lactis gigas (Micrococcus), 235 lactis harrisonii (Bacillus), 434 lacits innocuus (Streptococcus), 340

kar:s inocuus (Bacillus), 679 uctis inocuus (Bacterium), 679 lactis longi (Bacterium), 702 lactis lutea (Sarcina), 202 lactis marshalli (Bacterium), 415 lactis minutissimus (Micrococcus), 265 lactis niger (Bacillus), 711 lactis peptonans (Bacillus), 751 lactis pituitosi (Bacillus), 684 lactis pituitosi (Bacterium), 684 lactis pruchti (Bacillus), 788 lactis rosaceus (Micrococcus), 265, 273 lactis rubidus (Micrococcus), 274 lactis rugosus (Micrococcus), 265 lactis saponacei (Bacillus), 145, 668 lactes termophilus (Bacellus), 733, 756 lactis varians (Micrococcus), 210, 241, 265 lactis var. anoxyphilus (Streptococcus), lactis var. hollandicus (Streptococcus),

lactis var. malligenes (Streptococcus), 44, 325

lactis var. tardus (Streptococcus), 325 lactis viscosi (Coccus), 238 lactis riscosi (Micrococcus), 238 lactis viscosum (Bacterium), 414 lactis viscosus (Bacillus), 414 lactis viscosus (Micrococcus), 238, 280 lactis viscosus B (Micrococcus), 280 Lactobacillus, 18, 21, 25, 31, 37, 38, 42, 349, 350, 361, 367, 407, 675

Lactobacter, 349 Lactobacterium, 349 lactobutyricum (Granulobacter), \$22 lactobutyricus (Amylobacter), 822 lactobuturious (Bacillus), 822 Lactococcus, 312 lactofoetidus (Bacillus), 660

lactopropylbutylicum (Clostridium), 814 lactopropylbutyricus (Bacillus), 814 liquefaciens non lactopropylbutyricus (Bacillus), 814

lactorubefaciens (Bacillus), 644 lactorubefaciens (Bacterium), 654 lactorubefaciens (Serratia), 614

Lactosarcina, 285 Lactrimatoria, 5 lactucae (Bacillus), 746 lactucae (Bacterium), 168 lactucae (Marmor), 1178 lactucae (Phytomonas), 188 lacturae (Xanthomonas), 168 lactucae-scariolae (Phytomonas), 154 lactucae-scariolae (Xanthomonas), 154 lacunata (Moraxella), 690 lacunatum (Flavobacterium), 441 lacunatus (Bacillus), 441, 590 lacunatus (Bacterium), 441 lacunatus (Hemophilus), 590 lacunatus var. atupica (Morazella), 501 lacunogenes (Pseudomonas), 177 laerii (Bacterium), 680 laesiofaciens (Marmor), 1168 laesiofaciens var. minus (Marmor), 1168 laeris (Bacillus), 575, 709 laeris (Bacteroides), 575 laevolacticum (Bacterium), 348, 630 laevulosinertis (Micrococcus), 606 lagerheimii (Leuconastoc), 318 lagerhermit (Streptococcus), 348 lagerheimir var. subterraneum (Strepto coccus), 341 lagopodis (Spirochaeta), 1667 lagopodis (Spironema), 1067 laidlawi (Sapromyces), 1294 laminariae (Bacterium), 680 laminariae (Billetia), 680 laminariae (Kurthia), 680 Lamprella, 13, 83 Lamprocystis, 16, 23, 25, 817, 819, 819, 850, 855 Lampropedia, 23, 25, 814 lanceolatus (Bacillus), 660 lanceolatus (Diplococcus), 307 lanceolatus (Micrococcus), 307 lanceolatus (Pneumococcus), 397 lanceolatus (Streptococcus), 303, 333 lanceolalus anaerobius (Coccus), 230 lunceolatus capsulatus (Diplococcus), 307 lanceolatus ovium (Diplococcus) (Streptococcus), 341

lanceolatus pasteuri (Streptococcus), 306, lanceolatus sive capsulatus (Diplococcus). 306 lanceolatus var mucosus (Diplococcus). lanceolatus var. mucosus (Streptococcus). Ianfranchii (Actinomyces), 927 lanfranchii (Nocardia), 927 Ianakatense (Bacterium), 680 Lankasteron, 847 Lankoides, 10, 516 lanuginosum (Synangium), 1033 lanuginosus (Chondromyces), 1033 lapillus (Streptococcus), 341 lapsa (Phylomonas), 124 lapsa (Pseudomonas), 124 lardarsus (Micrococcus), 265 largum (Bactersum), 680 largus (Bacillus), 680 ları (Treponema), 1075 larvae (Achromobacter), 425 larvae (Bacillus), 726 larvae (Enterobacillus), 425 larvicida (Bacillus), 600 · larvicida (Bacterium), 660 lasers (Bacillus), 612 lasta (Pseudomonas), 147 lasiocampa (Bacıllus), 716 lassar: (Bacillus), 660 lasserei (Actinomyces), 920 lasserei (Discomyces), 920 lasseres (Nocardia), 920 lasseres (Oospora), 920 lasseuri (Flarobacterium), 178 lalapici (Spironema), 1064 lataptei (Spirillum), 1054 latapiei (Spirochaeta), 1064 latens (Rabula), 1236 latens (Sphaerothrix), 986 latericea (Serratia), 611

latericeum (Bacterium), 641, 683

Interesporus (Bacillus), 721, 725

lathridii (Streptothrix), 931, 971

latericeus (Bacillus), 641, 683

lathridis (Actinomyces), 971

lathuri (Bacıllus), 476 lathyri (Erwinia), 476 latum (Carvophanon), 1004 latvianus (Bacillus), 746 laurentia (Pseudomonas), 233 lauterbornii (Pelodictyon), 871 lautus (Bacıllus), 746 lavendulae (Actinomyces), 944, 977 lavendulae (Streptomyces), 944 laverans (Spirochaela), 215 laterani (Spironema), 215 laverani (Treponema), 215 laxae (Bacterium), 762 lebeni (Bacıllus), 364 lebenis (Bacterium), 364 lebenss (Streptobacellus), 351, 364 lebensis a and \$ (Streptobacillus), 364 lebenis nonviscosus (Streptobacillus), 364 lebenis viscosus (Streptobacillus), 364 lectularia (Richettsia), 1096 legers (Fusiformis), 694 legers (Microspironema), 1073 legers (Treponema), 1073 Legio, 1257 legrosit (Bacillus), 746 leguminiperdum (Baclerium), 747 leguminiperdus (Bacillus), 747 leguminosarum (Marmor), 1179 leguminosarum (Phytomyza), 224 leguminosarum (Rhizobium), 224, 225 226, 1130, 1138 leguminosarum (Schinzia), 224 lehmannı (Bacıllus), 747 leichmanni (Bactersum), 324 leschmanni I (Bacellus), 357 leichmanni II (Bacıllus), 356 leichmanni III (Bacillus), 357 leichmannii (Lactobacillus), 357

etekmanni (Bacillus), 357
leichmanni (Bacillus), 357
leichmanni II (Bacillus), 357
leichmanni II (Bacillus), 353
leichmanni II (Bacillus), 353
leichmanni (Lactobacillus), 351
leichmanni (Lactobacillus), 1eidenasa (Vibrao), 205
leishmanni (Cactobacillus), 1eidenasa (Vibrao), 205
leishmanni (Nocardia), 899
leishmanni (Nocardia), 899
leliinus (Bacillus), 747
leionis (Stephothriz), 977
lembte (Bacterum), 533
lembte (Marcoccus), 255

lembkei (Sarcina), 292 lembkii (Pseudomonas), 148 lemonnieri (Bacillus), 178 lemonnieri (Pseudomonas), 178 lenis (Alcaligenes), 416 lentiformis (Bacillus), 660 lentimorbus (Bacillus), 727 lentoputrescens (Clostridium), 793, 800 826 lentulum (Bacterium), 637 lentum (Eubacterium), 368 lentus (Bacillus), 713 lentus (Bacteroides), 368 lentus (Micrococcus), 255 lentus (Phagus), 1143 lenius (Streptococcus), 335, 341 leonardii (Vibrio), 200 lepierrei (Bacterium), 680 lepiseptica (Pasteurella), 547 lepisepticum (Bacterium), 547 lepisepticus (Bacillus), 547 leponis (Aerobacter), 456 leporis (Bacıllus), 451 leports (Eberthella), 451 leports (Escherichia), 451 leporis lethalis (Bacillus), 451 leporis lethalis (Bacterium), 451 leporisepticum (Bacterium), 547 leprae (Bacillus), 881 leprae (Coccothrix), 882 leprae (Discomyces), 882 leprae (Mycobacterium), 875, 881, 882, leprae (Sclerothrix), 882 leprae hominus (Mycobacterium), 882 leprae murium (Bacillus), 882 lepraemurum (Mycobacterium), 875, 882 lepromatis (Actinomyces), 916 lepta (Saprospira), 1054 leptinotarsae (Bacıllus), 660 leptodermis (Bacillus), 712 leptomitiformis (Beggiatoa), 992, 993 leptomitiformis (Oscillatoria), 992 Leptospira, 19, 20, 26, 28, 593, 594, 1076 leptosporus (Bacıllus), 710 Leptotrichia, 14, 19, 21, 22, 27, 34, 35,

38, 364, 365, 983

Leptothrix, 17, 18, 19, 23, 26, 364, 365, 933, 986 Leptothrix I, 367 Leptothrix II, 367 Leptothrix III, 365 lesagei (Bacıllus), 660, 747 lespedezae (Phytomonas), 159 lespedezae (Xanthomonas), 159 lestoquardi (Rickettsia), 1120 lethale (Marmor), 1155, 1168 lethalis (Bacillus), 680 lethalis (Bacterium), 680 lethalis (Proteus), 680 Lethum, 1223 leubei (Urobacillus), 688, 729 leucaemiae (Bacillus), 680 leucaemiae (Bacterium), 680 leucaemiae canis (Bacıllus), 680 leucaemiae canis (Bacterium), 680 leucea (Streptothrix), 934, 977 leucea suprophytica (Streptothrez), 976 leucoglocum (Bacterium), 637 leucomelaenum (Spirillum), 217, 218 Leuconostoc, 14, 20, 24, 31, 34, 345, 362 leucotermilis (Spirochaeta), 1067 Leucothrix, 695 levaditis (Treponema), 1070 Icvaniformans (Bacellus), 747 levans (Aerobacter), 455, 664 levans (Bacillus), 455 levans (Bacterium), 455 levans (Clouca), 455 levis (Rabula), 1235 levistici (Bacterium), 140 levistics (Phytomonas), 140 levistici (Pseudomonas), 140 levyi (Actinomyces), 916 lewisi (Pacinia), 701 lewisti (Bacterium), 534 lewisia (Eberthella), 531 lezington (Salmonella), 524 libaviense (Bacterium), 341 libaviensis (Streptococcus), 311 liber (Phagus), 1142 liborii (Clostridium), 820 liceagi (Salmonella), 531 lichenicolum (Podangium), 1035

licheniforme (Clostridium), 747 licheniformis (Bacillus), 747 licheniformis (Micrococcus), 265 lichenis plani (Ristella), 576 lichenocolus (Chondryomyces), 1035 lichenoides (Bacillus), 747, 814 lichnoides (Pneumococcus), 697 Lieskeella, 986 lieskei (Actinomuces), 950, 974 lieskei (Streptomyces), 950, 974 lignicola (Pseudomonas), 142 lignieresi (Actinobacillus), 556, 926 lignieress (Discomyces), 557 lignieresi (Nocardia), 557 lignieresi (Pasteurella), 557 lignieri (Bacillus), 556, 677 lignithum (Micrococcus), 266 lionivorans (Bacillus), 747 lignorum (Bacıllus), 747 liquire (Actinomyces), 975 liguire (Nocardia), 975 ligustri (Bacterium), 128 ligustrı (Marmor), 1187 ligustri (Pseudomonas), 128 lilacinus (Bacillus), 233 lilii (Adelonosus), 1211 lılıî (Bacillus), 477 lılıı (Erwinia), 477 limae (Cristispira), 1056 limae (Spirochaeta), 1056

limbatus acidi lactici (Bacillus), 681 limbatus butyri (Bacillus), 680 limcola (Bacillus), 680 limicola (Bacillus), 680 limicola (Chlorobium), 870, 872 limicola (Chlorobium), 870 liminani (Bacillus), 530 limneticum (Sideroderma), 835 limnophilus (Bacillus), 747 limonuticus (Siderococcus), 835 limnosius (Bacillus), 716 limosum (Lubacterium), 305 limosus (Bacillus), 715, 716, 815 limosus (Bacillus), 305, 370, 380 lindenboru (Bacillus), 491 lindneri (Actolhacter), 185 lindneri (Bacıllus), 360 lindneri (Lactobacillus), 360 Indneri (Pseudomonas), 106 lineare (Siderobacter), 835 linearis (Chroostipes), 873 linearius (Thermobacillus), 734 lineatus (Bacillus), 660 linens (Bacterium), 601, 612 lineola (Bacillus), 597, 681 lineola (Bacterium), 597, 681 lineola (Treponema), 1071 Ineola (Vibrio), 597, 1071 lineopictum (Marmor), 1197 lineards (Bacillus), 747 linguae (Spirillum), 205, 920 linguale (Spirosoma), 205, 920 lingualia (Actinomyces), 920 Innualis (Discomuces), 920, 922 lingualis (Nocardia), 205, 920, 922 lingualis (Oospora), 922 lingualis (Streptothrix), 920 lingualis (Vibrio), 205, 920 lini (Bacterium), 681, 818 linkoi (Bacterium), 681 linoanathi (Rickettsia), 1098 linsbaueri (Chromatium), 867 linsbaueri (Rhabdochromatium), 855 linsbaueri (Rhabdomonas), 855, 856 Isodermos (Bacillus), 709 liparis (Bacillus), 860 liparis (Diplococcus), 336 Ispidis (Achromobacter), 418 lipidis (Bacterium), 416 lipmanii (Actinomyces), 952 lipmann (Streptomyces), 952 Inpoferum (Chromatium), 203, 216 hpoferum (Spirillum), 203, 216 Inpolyticum (Achromobacter), 609 Inpolyticum (Bocternum), 391 Ispolyticum (Bactridium), 609 Ispolyticum (Kurthia), 693 Ispolyticus (Alcaligenes), 391 lipolyticus (Bacterium), 300, 693 lipolyticus (Micrococcus), 266 liquota (Cellulomonas), 396, 614 hquatum (Bacterium), 396, 614 liquefaciens (Achromobacter), 418

þ

liguefaciens (Actinomyces), 975, 976 liquefaciens (Aerobacter), 455, 692 liquefaciens (Amylobacter), 823 liquefaciens (Bacillus), 148, 388, 404, 418, 457, 660, 661 liquefaciens (Bacterium), 457 liquefaciens (Bacteroides), 575 liquefaciens (Cladothrix), 934, 975, 976 liquefactens (Coccobacillus), 575 liquefaciens (Corynebacterium), 371, 383, 404 liquefaciens (Diplobacil'us), 591 liquefaciens (Discomyces), 976 liquefaciens (Gluconoacelobacter), 694 liquefaciens (Gluconobacter), 694 liquefaciena (Microbacterium), 371 liquefaciens (Micrococcus), 238, 240, 266, liquefactens (Microspira), 193 liquefacions (Moravella), 591 liquefactens (Nocardia), 923, 975 liquefaciens (Oospora), 976 liquefaciens (Pseudomonas), 148 liquefaciens (Sarcina), 288, 292 liquefaciena (Streptococcus), 240, 325, 327, 702 liquefaciens (Streptothrix), 976 liquefaciens (Tetracoccus), 240 liquefaciens (Vibrio), 198 liquefaciens acid: I and II (Micrococcus). 266 liquefaciens albus (Bacillus), 661 liquefaciens albus (Micrococcus), 274 liquefaciens aurantracus (Staphylococcus), 282 liquefaciens bovis (Pneumobacıllus), 675 liquefaciens communis (Bacillus), 661, 681, 699 liquefaciens communis (Bacterium), 661, liquefaciens conjunctivae (Micrococcus), liquefaciens flueggei (Micrococcus), 266

liquefaciens lactie amors (Bacillus), 648

liquefaciens parvus (Bacillus), 822

liquefaciens pyogenes (Bacillus), 388

liquefaciens magnus (Bacillus), 787, 825

liquefaciens pyogenes boris (Bacillus), 383 liquefaciens septicus (Urobacillus), 491 liquida (Pseudomonas), 425, 699 Liquidobacterium, 8, 486 Liquidococcus, 8, 235 Liquidomonas, 8, 83 Liquidovibrio, 8, 192 liquidum (Achromobacter), 425, 693 liquidum (Bacterium), 425 liquidus (Bacıllus), 425, 699 liquidus (Micrococcus), 266 liquidus communis (Bacillus), 661 liskey (Actinomyces), 974 liskeyi (Asteroides), 974 lissabonensis (Vibrio), 205 Listerella, 20, 408 listeri (Actinomyces), 961 tisteri (Bacillus), 356 listeri (Lactobacillus), 356 listeri (Lactobacterium), 356 listeri (Pseudomonas), 143 listeri (Streptomyces), 981 Listeria, 408 litchfield (Salmonella), 514 litorale (Achromobacter), 425 litarale var. 2 (Achromobacler), 425 litoralis (Bacıllus), 425 litoralis (Bacterium), 423 litoralis (Erythroconis), 289 litoralis (Merismopedia), 289 litoralis (Micrococcus), 288 litoralis (Pediococcus), 289 litoralis (Pseudomonas), 425 literalis gadidarum (Micrococcus), 289 litoreum (Bacterium), 681 Istoreus (Bacillus), 681 litorosus (Bacillus), 661 Ittoralis (Erythroconis), 813 littoralis (Lampropedia), 289 Interests (Merismopedia), 843 littoralis (Sarcina), 288, 289 Livida (Sarcina), 292 livido-lutescens (Sarcina), 291, 292 lividum (Chromobacterium), 234 lividus (Bacillus), 234, 747 Ispidus (Bacterium), 234 Iobatus (Bacillus), 733

lobatus (Micrococcus), 266 lobatus (Thiobacillus), 81 loculosum (Bacterium), 681 Loefflerella, 37, 554 loeffleri (Pacinia), 383 loeffleri (Planococcus), 281 lochnisis (Bacillus), 728 lochnisii (Bacterium), 477 lochnisii (Phytomonas), 477 Lochnisium, 14 loewenbergu (Micrococcus), 265 lnewenbergii (Sarcina), 232 loganobacci (Nanus), 1208 loidensis (Actinomyces), 971 loligo (Coccobacillus), 636 loma linda (Salmonella), 522 londinensis (Actinomyces), 921 londinensis (Discomuces), 921 londinensis (Nocardia), 921 london (Salmonella), 522 londonensis (Salmonella), 522 longa (Pssudomonas), 148, 600 longiarticulata (Thiothrix), 990 longior (Bacillus), 747 longissima (Chlamydothrix), 1002 longissima (Pontothrix), 1002 longissimus (Streptococcus), 315 longum (Bacterium), 760 longum (Betabacterium), 360 longum (Rhodospirillum), 867 longus (Bacillus), 747, 815 longus (Lactobacillus), 351, 360 longus (Streptobacillus), 352 longus (Streptococcus), 315 longus hemolyticus (Streptococcus), 315 longus pathogenes seu erusi pelatos (Streptococcus), 315 lopholes (Leptothrix), 985 lophomonadis (Fusiformis), 604 losanitchi (Baciltus), 732 loti (Rhizobium), 225 lotti: (Catenabacterium), 368 louisianae (Miyagawancila), 1118 lorati (Spirochaeta), 1037 lowenthali (Spirochaeta), 1067 loxiacida (Bacıltus), 661

loxosporus (Bacıllus), 718, 748

loxosus (Bacillus), 716 lubinskii (Bacillus), 815 lucae (Streptococcus), 341 lucens (Bacterium), 635 lucens (Micrococcus), 635 luceti (Bacterium), 681 luciana (Salmonella), 526 lucidus (Bacillus), 661 luciliarum (Neisseria), 301 luciliae (Clostridium), 779 lucrosa (Cellulomonas), 614 lucrosum (Bacterium), 614 Iudwigi (Bacterium), 681 luis (Trypanosoma), 1071 luminosa (Microspira), 635 luminosum (Achromobacter), 634 luminosum (Photobacter), 635 luminosum (Photobacterium), 631, 635, luminosus (Bacillus), 635 luminosus (Bacterium), 635 luminosus (Vibrio), 635 lumnitzeri (Bacterium), 739 lunovensis (Bacillus), 544 lunovensis (Bacterium), 544 lunavensis (Shigella), 544 lunula (Bacterium), 760 lupi (Bacıllus), 661 lupini (Bacillus), 661 lupin: (Phytomyza), 226 lupin (Rhizobium), 221, 226 luridus (Micrococcus), 266 lustigni (Bacillus), 661, 668, 804 lustigu (Clostridium), 801 lustigii (Endosporus), 801 lutea (Cytophaga), 1013 lutea (Neisseria), 281, 696 lutea (Nocardia), 909 lutea (Sarcina), 253, 287, 290, 291, 292, 293, 294 luteo-albus (Bacillus), 661 luteola (Aphanothece), 871 luteola (Nocardia), 924

luteola (Aphanotheco), 871 luteola (Nocardia), 921 luteola (Oospora), 924 luteola (Sarcina), 232 luteola (Schmidlea), 871, 874 luteola (Streptothrix), 924

luteolum (Bacterium), 681 luteolus (Actinomyces), 924 luteolus (Discomyces), 924 luteolus (Micrococcus), 266 luteo-roseus (Actinomyces), 971 lutescens (Bacterium), 436, 681 lutescens (Flavobacterium), 436 lulescens (Sarcina), 292 lutetiensis (Bacillus), 233, 661 luteum (Ascobacterium), 647 luteum (Bacterrum), 681 luteum (Bacteridium), 237 luteum (Mycobacterium), 890 luteum (Polyangium), 1027 Iuleus (Actinomyces), 909 luteus (Bacillus), 661, 690, 748 luteus (Diplococcus), 281, 694, 696 luteus (Micrococcus), 43, 237, 251, 256, 257, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 275, 276, 277, 278, 280 luteus (Mycococcus), 891 luteus (Planococcus), 281, 694 luteus (Streptococcus), 341 luteus liquefaciens (Bacillus), 490 luteus-liquefaciens var larvae (Micrococcus), 266 luteus pallescens (Bacillus), 661 luteus putidus (Bacillus), 647 luteus sporogenes (Bacıllus), 748 luteus yar. larvae (Micrococcus), 266 lutosus (Micrococcus), 266 lutrae (Spirochaeta), 1067 lutrae (Spironema), 1067 lutrae (Spiroschaudinnia), 1067 lutulentus (Bacıllus), 716 lutzae (Bacıllus), 274, 301, 748 lwoffi (Morazella), 592 lycopersici (Bacterium), 477 lucopersici (Lactobacillus), 358 lycopersics var. vitials (Bacterium), 640 Iucopersicum (Phytobacter), 145 lydiae (Bacterium), 760 lymantriae (Bacillus), 661 lymantriae (Bacillus) (Bacterium), 661

lymantriae (Coccobacillus), 661

lymantriae (Diplococcus), 336

lymantriae a (Bacillus), 661
lymantriae B (Bacillus), 661
lymantricola adiposus (Bactlus), 661
lymantricola adiposus (Bacterium), 661
lymphae vaccinalis (Corynebacterium) 401, 404
lymphatacum (Treponema), 1968
lymphaticus (Spirochaela), 1967
lymphogranulomatis (Altyagawanella), 1116, 1117, 1118, 1119
lymphogranulomatis (Ehrlichia), 1116
lymphophilum (Corynebacterium), 383, 404
lymphophilus (Bacillus), 404

lysoderkticus (Micrococcus), 266

lyssae (Cocco-bacterium), 266

lyssae (Glugea), 1264

lyssae (Micrococcus), 266

lyticus (Bacillus), 815

maase: (Microspira), 202 maasei (Spirillum), 202 macaci (Spirochaeta), 1068 macaci (Spironema), 1068 macaci (Spiroschaudinnio), 1068 maccullochianum (Bacterium), 117 macerans (Aerobacıllus), 721 macerans (Bacillus), 720, 721, 722 723 macerans (Zumobacillus), 721 macfadyeanii (Bactersum), 531 macfadyeanii (Salmonella), 531 Macintoskillus, 11, 763 Macrocystita, 14 macrodentium (Spirochaeta), 1075 macrodentium (Treponema), 1070, 1075 macrodipodidarum (Actinomyces), 921 macrodipodidarum (Nocardia), 921 Macromonas, 997, 1000 macrophysa (Throphysa), 993, 999 macroselmis (Pseudomonas), 146, 148, 65 macrospora (Palmula), 728 macrosporus (Acuformis), 798 macrosporus (Bacillus), 815 macrosporus (Chondrococcus), 1045 macrosporus (Myzococcus), 1016 mactrae (Cristispira), 1056 mactrae (Spirochaeta), 1056

magnusson-holth (Corynebacterium), 391 maculans (Phagus), 1139 maidis (Bacillus), 148, 748 maculata (Nocardia), 913 maidis (Fractilinea), 1159 maculatum (Corvnebacterium), 404 maculatus (Actinomyces), 913 maidis (Marmor), 1159 maids (Phagus), 1136 maculatus (Bacıllus), 404, 748 maculatus (Proactinomyces), 913 maidis (Pseudomonas), 148, 748 maidis var. mitis (Fractilinea), 1160 maculicola (Aplanobacter), 639 maculscola (Bacillus), 639 maidis var. sacchari (Fractilinea). 1159 maculicala (Bacterium), 639 maidis var. tupicum (Fractilinea), 1159 maculicala (Phytomonas), 117 mager (Bacillus), 661 maculicola (Pseudomonas), 117 mater (Becautea), 992 maculicola var. naponicum (Bacterium). major (Gallionella), 832 major (Leptothrix), 986 maculicolum (Bacterrum), 117 major (Micrococcus), 267 major (Phagus), 1133 maculifolium - gardeniae (Phytomonas), major (Siderocapsa), 833 major (Siderothece), 835 madampensis (Bacıllus), 542 madampensis (Lankoides), 542 maius (Thiovulum), 1000 makrono-filiformis (Bacillus), 815 madampensis (Shigella), \$40, \$42 maddozı (Bacıllus), 729 malabarensis (Bacillus), 714 maddozı (Bacterium), 729 malae (Streptobacillus), 336 madelia (Salmonella), 628 malae (Streptococcus), 336 madidus (Bacillus), 661 malahofaciens (Bacillus), 748 madidus (Micrococcus), 266 malamoria (Vibrio), 205 madoxii (Urobacıllus), 729 malaperti (Streptococcus), 341 madurae (Actinomyces), 908, 909 malariae (Bacillus), 661 madurae (Cladothrix), 908 malencon: (Actinomuces), 939 madurae (Discomyces), 908 malenconu (Streptomyces), 939 madurae (Nocardia), 908, 909, 960 malenominatum (Clostridium), 786 madurae (Oospora), 908 malenominatum (Paraplectrum), 786 madurae (Streptothrix), 908, 915, 924 malenominatus (Bacillus), 786 maerchi (Bacillus), 356 mali (Bactersum), 640 maggiorae (Pediococcus), 290 malı (Marmor), 1194 maggiora: (Bacillus), 661, 803 maligni (Novillus), 777 maggiorai (Clostridium), 803 malignus (Streptococcus), 341 maggiorai (Endosporus), 803 malles (Aclinobacillus), 555 magna (Cornilia), 787 maller (Bacillus), 555 maam .... /1 mallei (Bactersum), 555 maller (Brucella), 555 maller (Cladascus), 555 mallei (Corynebactersum), 555 malles (Loefflerella), 555 mallei (Malleomyces), 555 mallei (Mycobacterium), 555 maller (Pferfferella), 555

maller (Sclerothrix), 555

Malleomyces, 25, 27, 554

magnus anaerobius (Diplococcus), 30S

magnus liquefaciens (Bacillus), 787

malelacticus (Micrococcus), 267 malvaccarum (Bacillus), 159 malracearum (Bacterium), 159 malracearum (Phytomonas), 159 malracearum (Pseudomonas), 159 malvacearum (Xnnthomonas), 159, 1136 malraccarum var. barbadense Bacterium), 178 mammitidis (Bacillus), 662 mammitis (Micrococcus), 267 mammilis boris (Streptococcus), 267, 311 Mammococcus, 327 manchuriae (Rickettsia), 1085, 1086 manfredii (Micrococcus), 267

manifests (Materiocecis), 267
manganicus (Bacillus), 662
manganifera (Crenothriz), 957
mangifera (Bacillus), 474
mangiferae (Bacillus), 474
manhaltan (Salmonella), 514
manihotus (Bacillus), 170
manihotus (Bacterium), 170

manihotis (Phytomonas), 170 manihotis (Xanthomonas), 170 mannitocremoris (Streptococcus), 325 mannitopoeum (Bacterium), 359 mannitopoeus (Lactobacillus), 359

mannetopoeux var fermentus (Lactobacillus), 359 mansfeldii (Bacterium), 760 Mantegazzaca, 853 marcescens (Bacsilus), 480

marcescens (Bacillus), 450
marcescens (Salmonella), 450
marcescens (Serratia), 10, 479, 481, 482,
483, 484, 485

483, 485, 485 as marchouxi (Spirochaela), 1058 marchouxi (Spiroschaudinnia), marchouxi (Spiroschaudinnia), marchouxi (Treponema), 1059 margarineum (Baclerium), 651 margarineus (Bacultus), 662 margarilaceus (Streplococcus), 311 margarilaceus (Baclerium), 457 marginale (Anaplasma), 1100 marginale (Bacterium), 125 marginalis (Phytomonus), 125 marginalis (Peudomonus), 125 marginalis (Peudomonus), 125 marginalis (Peudomonus), 125

marginans (Marmor), 1195 marginata (Phytomonas), 118 marginata (Pseudomonas), 118 marginata (Sarcing), 292 marginatum (Baclerium), 118 marginatus (Actinomyces), 971 marginatus (Micrococcus), 267 marianensis (Bacillus), 589 maricola (Bacillus), 662 mariense (Bacillus), 416 marina (Beggiatoa), 991, 992 marina (Microspira), 205 marina (Spirochaeta), 1052 marina (Thiothrix), 990 marinagilis (Vibrio), 703 marinoflarus (Vibrio), 703 marinofulvus (Vibrio), 703 marinogluticosa (Pseudomonas), 107 marinoglutinosus (Achromobacter), 107 marinolimosus (Actinomyces), 971 marinopersica (Pseudomonas), 699 marinopiscosus (Bacterium), 808 marinopraesens (Vibrio), 703 marinorubra (Serratia), 484 marinotypicum (Flavobacterium), 431 marinovirosum (Flavobacterium), 431 marinovulgaris (Vibrio), 703 marinum (Bacterium), 681 marinum (Flavobacterium), 433 mariaum (Mycobacterium), 883, 884, 886 887 marinum (Spirillum), 205

marinum (Spirillum), 205
marinus (Hicrococcus), 267
marinus (Vibrio), 203, 205
marispuniceus (Micrococcus), 606
maris (Flavobacterium), 611
maris-mortus (Chromobacterium), 234
maris-mortus (Flavobacterium) (Halobac
terium), 422

maritimum (Bacterium), 748 maritimus (Bacillus), 748 markusfeldri (Bacterium), 760 Mermor, 1163, 1202 marmorans (Scelus), 1238 marmotae (Spirochaeta), 1068 marocanum (Spurochaeta), 1067 marseille (Salmonella), 526 Gelatin: Liquefied (Burkholder).

Acid but no gas is produced from

glucose, sucrose, maltose, lactose, glyeerine, arabinose, vylose, galactose, raffinose and manutol.

Slight growth in broth plus 5 per cent salt (Burkholder). Source: Isolated from stalk rot of field

corn in California; also from Diabrotica

Habitat. Pathogenic on corn and sugar cane.

Note: Like Pseudomonas dessana.

91. Pseudomonas bowiesiae (Lewis and Watson) Donson. (Phytomonas bowlesii Lewis and Watson, Phytopath, 17, 1927, 611; Bacterium bowlesii Elhott, Bacterial Plant Pathogens, 1930, 96, Donson, Trans. Brit Mycol Soc. 26, 1913, 9) From M. L. Bowlesia, a generic name.

Rods: 0 5 to 0 7 by 1 2 to 1 6 microns, occurring singly, in pairs or in short chains. Motilo with bipolar flagella. Gram-negative

Green fluorescent pigment produced in culture.

Gelatin: Liquefied.

Agar slants · Yellowish, moist, glistening and viscid

Broth: Uniform turbidity throughout Heavy viscous sediment in old cultures Milk: Alkaline; coagulation, with a slow peptonization.

Nitrites are produced from nitrates.

Indole is produced.

Hydrogen sulfide is produced

Acid from glucose, maltose and xylose. No acid from sucrose.

Optimum temperature 27°C. Maximum 37°C. Minimum —1°C.

Optimum pH 7 2, pH range 4 5 to 8 6. Aerobic.

Source: Isolated from diseased, water soaked spots of bowlesia.

Habitat: Pathogenic on Bowlesia septentrionalis.

95. Pseudomonas intybi (Swingle) Stapp (Phytomonas intybi Swingle, Phytopath., 15, 1925, 730; Stapp, in Soraurer, Handbuch der Pflanzenkrankeiten, 2, 5 Auf , 1928, 291; Bacterium intyb. Elliott, Bacterial Plant Pathogens, 1930, 142.) From Latin, intibus, endive

Description from Stapp, Cent f. Bakt., II Abt., 91, 1935, 232.

Rods: 0.4 to 0.5 by 1.4 to 2.8 microns. Motile with one to several polar flagella Gram-negative.

Green fluorescent pigment formed in culture.

Gelatin: Liquefaction.

Agar colonies: White, glistening, transparent

Broth. Turbid with fragile pellicle, and good sediment.

Milk: Coagulated. Casein not peptonized.

Nitrates are produced from nitrates with the formation of gas.

Indole not formed.

Acid but not gas from arabinose, xylose and glucose. No acid from sucrose

Optimum temperature 23° to 28°C.

Maximum 40° to 42°C. Minimum 0°C.

Distinctive character: Differs from

Pseudomonas cichorn in that it liquefies gelatin and produces nitrites from nitrates.

Source Isolated from French endive, Cichorium intybus by Swingle, from C. endire and lettuce, Lactuca sativa by Stapp.

Habitat: Pathogenie on endive and lettuce, causing a rot.

96. Pseudomonas marginalis (Brown) Sievens (Bacterum marginale Brown, Jour Agr. Res., 15, 1918, 385, Phytomonas marginalis Bergey et al., Manual, 1st ed., 1923, 182, Stevens, Flant Disease Fungi, New York, 1925, 30) From Latin, margo (marginal), edge, margin M.L. marginalis, on the margin, a character of the disease.

Description from Brown (loc. cit.) and Clara (Cornell Agr. Exp. Sta Mem. 159, 1934, 27).

Rods: Motile with 1 to 3 polar flagella. Gram-negative.

megatherium (Bacillus), 632, 714, 717, 718, 738, 739, 744, 748, 750, 759, 1130, 1138 megatherium var. ravenelii (Bacillus), 748 megawi (Rickettsia), 1000 megawi var. fletcheri (Rickettsia), 1090 megawi var. pijperi (Rickettsia), 1088 Melanella, 5 melaninogenica (Ristella), 574, 575 melaninogenicum (Bacterium), 574 melaninogenicus (Bacteroides), 574, 575 melaninogenicus (Hemophilus), 574 melanocycla (Nocardia), 956 melanocyclus (Actinomyces), 267, 956 melanocyclus (Micrococcus), 267, 956 melanocyclus (Streptomyces), 966 melanogenes (Bacillus), 468, 469, 470 melanogenes (Streptococcus), 311 melanogenes canis (Spirochaeta), 1068 melanogenum (Acetobacter), 183 melanoglossophorus (Micrococcus) 267 melanoroseus (Actinomyces), 972 melanosporea (Nocardia), 955 melanosporeus (Actinomyces), 955 melanosporeus (Streptomyces), 955 melanosporus (Bacillus), 748 melanotica (Streptothrix), 977 melanorogenes (Proteus), 490 meldensis (Micrococcus), 267 meleagridis (Bacıllus), 662 melcagridis (Lactobacıllus), 407 meleagrides (Salmonella), 502, 523 melezitororum (Aerobacter), 456 meliflara (Sarcina), 292 meliloti (Rhizobium), 226 melitense (Bacterium), 561 melitensis (Alcaligenes), 561 melitensis (Bacillus), 561

melitensis var. suis (Brucella), 862 Mellittangum, 1031, 1033 mellea (Phytomonas), 130 mellea (Pseudomonas), 127, 130 melleum (Bacterium), 130

melitensis (Brucella), 42, 560, 561, 562

. . > OFO 560

melleus (Bacillus), 662 melleus grandinis (Micrococcus), 267 melloi (Bartonella), 1108 melloi (Haemobartonella), 1108 melochlora (Pseudomonas), 148, 699 melochloros (Baccillus), 148 melochlorus (Bacterium), 699 Melococcus, 235, 312 melolonthae (Bacillus), 662 melolonthae (Diplobacillus), 336, 690 melolonthae (Fusiformis), 694 melolonthae liquefaciens (Bacterium), 681 melolonthae liquefaciens a (Bacillus), 681 melolonthae liquefaciens α, β and γ (Bacillus), 682 melolonthae liquefaciens α, β and γ (Bac terium), 662 melolonthae non liquefaciens a, 8 an y (Bacillus), 662 melolonihae non-liquefaciens & (Bacillus) melolonthae non-liquefaciens e (Bacillut) 662 melonis (Bacillus), 474, 748 melonis (Erwinia), 474

662
melonis (Bacillus), 474, 748
melonis (Ervinia), 474
melonis (Fectobacterium), 474
melonis (Rickettisia), 1006, 1007
melophogi (Krickettisia), 1008
melophihora (Phytomona), 141
melophihora (Pseudomonas), 141
melophihora (Facterium), 141
melophih

231

bacterium), 231
membranaceum amethystinum II (Chr
mobacterium), 234
membranaceum amethystinum III (Chr
mobacterium), 234
membranaceum amethystinum IV (Chr
mobacterium), 234
membranaceus (Bacillus), 662
membranaceus (Bacillus), 662
membranaceus amethystinus (Bacillu
232
membranaceus amethystinus (Bacillu
membranaceus amethystinus (Bacillu

232

marshalli (Bacterium), 692 marshallii (Alcaligenes), 416, 416 692 marsiliensis (Bacterium), 662 marsilliensis (Bacıllus), 662 Martellellus, 11, 763 martinezzi (Bacıllus), 662 martinezu (Bacterium), 662 martuniae (Bacterium), 112 martuniae (Phytomonas), 112 martypiae (Pseudomonas), 112 maschekir (Pseudomonas), 148 massauah (Microspira), 205 massauah (Spirillum), 205 massauah (Vibrio) 205 massowah (Spirillum) 205 mastidis (Pasteurella) 553

mastridis gangraenoeue ovis (Micrococcus)
267
mastridis (Bacterium), 553
mastridis (Bicrococcus), 267, 284
mastridis (Sirococcus), 210

maetitidis (Micrococcus), 267, 284
maetitidis (Streptococcus), 319
mastitis (Micrococcus), 267
maetitis albus (Staphylococcus), 280
maetitis contagnosae (Streptococcus), 319

matruchoti (Actinomyces), 918 matruchoti (Cladothrix), 918 matruchoti (Nocardia), 918 matruchoti (Oospora), 918

..

maubianen (Pseudomonas), 140 maxima (Beggiatoa), 992 maxima (Butyrisarcina), 286 maxima (Leptotrichia), 366 maxima (Rasmussenia), 366 maxima (Sarcina), 238 maxima (Zumosarcina), 286 maxima buccalis (Leptothrix), 366 maximum (Phacus), 1134 maximum buccalis (Bacillus), 365 maximus (Bacillus), 366 maximus (Strentococcus), 341 mandis (Bacıllus), 681 maudis (Bacterium), 681 manamonei (Bacıllus), 815 mazei (Methanococcus), 248 mazun (Bacillus), 748 mazun (Bactersum), 362 medanense (Bacterium), 681 media (Beggiataa), 992 media (Spirachaeta), 1075 media (Spironema), 1075 media oris (Spirochaeta), 1075 medicaginis (Bacillus), 118 medicaginis (Bacterium). 118 medicaginis (Chlorogenus), 1151 medicaginis (Marmor), 1155, 1181 medicacinis (Phytomonas), 118 medicaginis (Pseudomonas), 118 phaseolicola (Bacmedicaginis var. terium), 118 medicaginis var. phaseolicola (Phytomonas). 118 medicaginis var phaseolicola (Pseudomonas), 118 medicaginis var solani (Marmor), 1181 medicaginis var. typicum (Marmor), 1181 medias porus (Bacillus), 748 medio-tumescens (Bacillus), 748 medium (Clostridium), 820 medium (Treponema), 1075 medius (Chondromyces), 1038 medius (Phagus), 1132 medius (Staphylococcus), 701 megalosporus (Bacillus), 815 megalosporus (Chondrococcus), 1045 megalasporus (Hiberillus), 815 megalosporus (Inflabilis), 815 Megalathrix, 981 menaterium (Bacillus), 714 megatersum bombycis (Bacillus), 739

Megatherium, 20, 22

metadysentericus var. A, B, C and D (Bacillus), 544 metadysentericus var. A, B, C, and D (Dysenteroides), 544 metaflavus (Bacillus), 662 metalcaligenes (Achromobacter), 414 metalcaligenes (Alcaligenes), 414, 416 metalcaligenes (Bacterium), 414 Metallacter, 6, 705, 763 metalloides (Pseudomonas), 148 metchnikovi (Actinomyces), 972 metchnikovi (Vibrio), 196 Metchnikovillus, 11, 763 metchnikowi (Oospora), 931, 972 metentericus (Micrococcus), 696 methanica (Methanomonas), 179 methanica (Methanosarcina), 287 methanica (Sarcina), 287 methanica (Zymosarcina), 287 methanicus (Bacillus), 179 methanigenes (Bacellus), 809 methanigenes (Cellobaeillus), 800 methanis (Bacillus), 509 Methanobacterium, 29, 30, 645, 646 Methanococcus, 29, 30, 248 Methanomonas, 20, 31, 82, 179 Methanosareina, 29, 30, 31, 285 methylicum (Bacterium), 643 methylicus (Bacillus), 643 metiens (Bacillus), 716 metritis (Corynebacterium), 401 metritis (Spirochaeta), 1068 metschnikoffii (Microspira), 196 metschnikoffi (Pacinia), 196 metschnikori (Spirillum), 196 mexicana (Nocardia), 019 mexicana (Salmonella), 531 mexicanus (Actinomyces), 919 mexicanus (Discomyces), 919 meyeri (Actinobactersum), 927 Meyerillus, 11, 763 miami (Salmonella), 519 micans (Bacillus), 749 micelomae (Actinomyces), 916 micetomae (Oospora), 916 micelomae-argentinae (Nocardia), 918 micelomas argentinae a (Streptothrix), 918

micetomae argentinae p (Streptothriz), 916 michaelisii (Bacillus), 733 micheli (Neisseria), 279, 696 micheli (Pacinia), 691 machiganeae (Erwinia), 394 michiganense (Aplanobacter), 391 michiganense (Baclerium), 393 michiganense (Corynebacterium), 393 michiganense (Pseudomonas), 393 michiganense var. saprophyticum (Corynebactersum), 391 michiganensis (Phagus), 1140 michiganensis (Phylomonas), 394 mecroapoilia (Streptococcus), 311 micro-apoikia enterstis (Streptococcus) 341 Microbacterium, 9, 349, 370, 371 microbutyricum (Bacterium), 590 Micrococcus, 13, 14, 15, 17, 19, 21, 25, 29, 31, 33, 42, 179, 235, 249, 200, 26, 276, 696, 1006, 1121 Microcolcus, 993 microdentium (Spirochaeta), 1075 microdentium (Treponema), 1071, 10 Microderma, 76 microflava (Micromonospora), 950 microflavus (Actinomyces), 950, 978 microflavus (Streptomyces), 950 microgyrata (Spirochaeta), 1074 microgyrata (Spironema), 1874 puerogyrata (Spiroschaudinnia), 1074 mierogyraia var. gaylordi (Spirochoe) microgyrata var. gaylords (Spironem microgyrata gaylordi (Spirochacta), l microgyratum (Treponema), 1074 Micromonospora, 875, 978 Micromyces, 925, 1291 microparta (Actinomyces), 976 microparia (Nocardia), 976 micropunctata (Nitrocystis), 75 micropunciala (Nitrogloca), 75 mieros (Streptococcus), 330, 331 Microsphaera, 235 Microspira, 7, 12, 16, 19, 28, 192, 1122

Microspironema, 1071 .

membranaceus amethystinus I (Bacillus). membranaceus amethystinus II (Bacillus). membranaceus amethystinus (Bacillus), 234 (Ramembranaceus amethustinus cillus), 234 membranaceus amethistinus mobilis (Bacillus), 233 membranifer (Bacillus), 612 membranoformis (Achromobacier), 107 membranoformis (Pseudomonas), 107 membranula (Pseudomonas), 699 memelonsis (Micrococcus), 267 mendozoe (Gaffkya), 284 mendozae (Micrococcus), 284 meningitidis (Bacillus), 662, 681 meningitidis (Coccobacillus), 589 meningilidis (Diplococcus), 297 meningitidis (Flaiobacterium), 490 meningitidis (Hemophilus), 589 meningitidis (Micrococcus), 297 meningitidis (Neisseria), 296, 297, 299, meningitidis (Streptoeoccus). 341 meningilidis aerogenes (Bacterium), 662 meningitidis cerebrospinalis septicemiae (Hemophilus), 585 meningitidis purulentae (Bacillus), 681 meningitis (Cillobacterium), 369 Meningococcus, 297 meningococcus cerebrospinalis (Micrococcus), 297 mephitica (Pseudomonas), 99 merdarius (Streptococcus), 341

merionis (Grohamella), 1110
merismoides (Nitrosogloes), 73
Merismopedia, 6
merismopedioides (Bacterium), 682
Merista, 235
merilanji (Microspronema), 1061
mesenterica (Nocardia), 907
mesenterica (Pseudomonas), 148
metantericum (Bacterium), 707
mesentericum (Microbacterium), 907
mesentericum (Microbacterium), 907
mesentericus (Agarbacterium), 629

(

!

6

ř

ŗ

mesentericus (Bacillus), 595, 709, 711, 712, 741, 748, 755, 760
mesentericus (Practinomyces), 907
mesentericus (Practinomyces), 907
mesentericus var. flavus (Bacillus), 710, 712
mesentericus aureus (Bacillus), 173, 693
mesentericus aureus (Bacillus), 173, 693
mesentericus aureus (Bacillus), 709, 737, 744
mesentericus fuscus (Bacillus), 709, 737, 748
mesentericus fuscus consistens (Bacillus), 748
mesentericus fuscus granulatus (Bacillus), 759

738
mesentericus hydrolyticus (Baeillus), 710
mesentericus neger (Bacillus), 711
mesentericus panis viscosi I (Bacillus),
760
mesentericus ponis viscosi II (Bacillus),
mesentericus ponis viscosi II (Bacillus),

mesenterieus ponis viscosi II (Bacillus), 710
mesenterieus voseus (Bacillus), 709, 748
mesenterieus ruber (Bacillus), 709, 748
mesenterieus vubgnonous (Bacillus), 749, 709, 741, 751
mesenterieus vulgotus (Bacillus), 709, 741, 751
mesenterieus vulgotus mucosus (Bacillus),

748
mesenterioides (Bacillus), 749
mesenterioides (Streptococcus), 346
mesenterioides (Aseococcus), 346
mesenteroides (Bacierium), 760
mesenteroides (Bacierium), 760
mesenteroides (Louionnostoc), 262, 263,
346, 343, 689

Metabacterum, 9, 762
metaboticus (Bacillus), 662
metaboticus (Bacillus), 452
metacol (Bocillus), 452
metacol (Bocillus), 452
metacol (Exchrichia), 452
metacolo (Exchrichia), 452
metacolodes (Bacillus), 452
metacolodes (Bacillus), 452
metacolodes (Exchrichia), 452
metacolodes (Frotus), 452
metadiffuens (Frotus), 450
metadiffuens (Frotus), 450
metadiffuens (Frotus), 514

metadysentericus (Castellanus), 514

Naumanniella, 831 navicula (Amylobacter), 771 navicula (Bacillus), 771 navicula (Bacterium), 771, 824 naviculum (Clostridium), 771 naviformis (Bacillus), 576, 723 naviformis (Ristella), 576 n'dianka (l'ibrio), 205 neapolitana (Escherichia), 447 neapolitanus (Bacillus), 447 neapolitanus (Bacterium), 447 nebulosa (Pseudomonas), 101, 699 nebulosum (Achromobacter), 101 nebulosus (Bacillus), 101, 580, 663, 749, S15 nebulosus (Bactersum), 699 nebulosus (Cryptococcus), 258 nebulosus (Protococcus), 258 nebulosus gazogenes (Bacillus), 749 necans (Bacillus), 663 neerodentalis (Bacillus), 361, 362 necrogenes (Bacıllus), 579 neerogenes (Spherophorus), 579 neerapkora (Pasteurella), 554 necraphora (Streptothrix), 578, 977 necraphorum (Bacterium), 578 necrophorum (Corynebacterium), 578 necrophorus (Actinomyces), 578 necrapharus (Bacıllus), 578 necrophorus (Pusiformis), 578, 583 necrophorus (Spherophorus), 578, 580, 583, 928 necrosans (Clostridium), 820 necroscos (Bacıllus), 578 necroscos (Streptococcus), 342 necroticans (Micrococcobacillus), 690 necroticus (Bacillus), 579 necroticus (Spherophorus), 579 necroticus (Streptococcus), 342 nectarophila (Bacterium), 134 nectorophila (Phytomonas), 134 nectarophila (Pseudomonas), 134 neddini (Actinomyccs), 916 negombensis (Bacillus), 514 negombensis (Shigella), 544 neigeux (Bacille), 777

neisseri (Pacinia), 386

Neisseria, 19, 21, 26, 27, 29, 31, 33, 295 nelliae (Bacillus), 478 nelliae (Erwinia), 478 nenekii (Achromobacter), 624 nenekii (Bacterium), 624 neocistes (Vibrio), 199 neoformans (Micrococcus), 268 neotropicalis (Borrelia), 1068 neotropicalis (Spirochaeta), 1064 neolropicalis (Treponema), 1064 nephriticus (Bacillus), 663 nephritidis (Bacterium), 553, 760, 761 nephritidis equi (Bacillus), 510 nephritidis insterlittalis (Bacillus), 760 neptunium (Flavobacterium), 432 nerstiea (Pseudomonas), 699 nerviciarens (Marmor), 1198 neschezadimenki (Actinomyces), 923 neschezadimenki (Cohnistreptothriz), 928 neumanns (Bacillus), 681, 749 neuralyticus (Musculomyces), 1293 neurotomae (Bacillus), 663 neurotomas (Bacterium), 663 neurotomae (Micrococcus), 268 neustonica (Naumanniella), 834 neuvillei (Micrococcus), 268 neveuxi (Spirochaeta), 1059 nercuxi (Spironema), 1059 nercuxi (Treponema), 1059 neveuzia (Sparoschaudannia), 1059 Nevskia, 7, 35, 829 new brunswick (Salmonella), 525 newington (Salmonella), 521 newport (Salmonella), 573 newportensis (Salmonella), 513 newport var. lottbus (Salmonella), 513 Newskia, 7, 12, 14 new york (Salmonella), 522 nexibilis (Bacillus), 148 nexibilis (Bacterium), 699 nexibilis (Pseudomonas), 148, 699 nexifer (Micrococcus), 696 nicolateri (Bacterium), 682 nicolaieri (Pacinia), 798 Nicollaterillus, 11, 763 nicolles (Actinomyces), 921 nicoller (Bartonella), 1108

Microsporum, 916 microsvorum (Bacterium), 682 micrott (Grahamella), 1110 microti (Haemobartonella), 1104 microti pennsulvanici (Grahamella), 1110 microtis (Bacillus), 682 microtis (Bacterium), 682 middletownii (Achromobacter), 425 middletownii (Bacterium), 425 Migulanum, 13, 705 mikawasima (Salmonella), 511 mildenbergii (Pseudomonas), 96, 146 Muletensis (streptococcus), 560 milu (Bacillus), 749 milleri (Microspira), 202 milleri (Spirillum), 202 milleri (Vibrio), 202 millerianus (Bacillus), 672 milletiae (Bacillus), 465 milletiae (Erwinia), 465 millinum (Corynebacterium), 404 Mima, 595 mina (Cristispira), 1056 mineacea (Streptothrez), 917 mineaceus (Actinomyces), 917 minei (Spirochaeta), 1070 mines (Treponema), 1070 miniacea (Serratia), 484 miniaceus (Bacillus), 484 miniaceus (Erythrobacillus), 484 minima (Beggiatoa), 993 minima (Laulerborniola), 859 minima (Nocardia), 902 minima (Spirochaeta), 1054 minima (Thiocapsa), 845 minima (Thioploca), 994 minimum (Microsporum), 916 minimum (Rhizobium), 226 minimum (Treponema), 1054 minimum (Trichophyton), 916 minimus (.ictinomyces), 916 minimus (Bacillus), 663 minimus (Micrococcus), 267, 268, 303 minimus (Phagus), 1131 minimus (Pronetinomyces), 902 minimus (Staphylococcus), 303

minnesola (Salmonella), 529

minor (Bacillus), 858 minor (Benniaton), 993 minor (Chondromyces), 1039 minor (Clostridium), 819 minor (Gallionella), 832 manor (Hudrogenomonas), 78 minor (Naumanniella), 834 minor (Phagus), 1131 minor (Rhabdomonas), 854 minor (Rhodococcus), 865 minor (Rhodorrhagus), 865 minor (Rhodosphaera), 865 minor (Siderocustis), 835 minor (Siderathece), 835 minor (Spirillum), 215 minor (Snironema), 215 minor (Treponema), 215 minus (Bacterium), 858 minus (Chromatium), 856, 857, 858, 859 minus (Polyangium), 1027 minus (Rhabdochromatium), 854 minus (Spirillum), 215 minus (Thiodictyon), 845 minus (Thiovulum), 1000 minus var. muris (Spirillum), 215 minus var. morsus muris (Spirillum), 215 minuscula (Cellulomonas), 105 minuscula (Pseudomonas), 105 minuta (Sarcina), 292 minuta (Smroschaudinnia), 1076 minutaferula (Bacterium), 605 minutissima (Eberthella), 607 minutissima (Microderma), 76 minutissima (Nocardia), 919 minutissima (Oospora), 019 minutessima (Pseudomonas), 148, 609 minutessima (Shigella), 607 minutesima (Thiothrix), 990 minutissimum (Bacterium), 580, 607, 859 minutissimum (Chromatium), 858 minutissimum (Microsporon), 919 minutissimum (Sporotrichum), 919 minutissimus (Actinomyces), 919 minutissimus (Bacillus), 663, 858 minutissimus (Discomyces), 919

minutissimus (Mierococcus), 26S, 304

minutissimus (Microsporoides), 919

Naumanniella, 834 navicula (Amylobacter), 771 navicula (Bacillus), 771 navicula (Bacterium), 771, 824 naviculum (Clostridium), 771 naviformis (Bacillus), 576, 723 naviformis (Ristella), 576 n'dianka (Vibrio), 205 neapolitana (Escherichia), 447 neapolitanus (Bacillus), 447 neapolitanus (Bacterium), 447 nebulosa (Pseudomonas), 101, 699 nebulosum (Achromobacter), 101 nebulosus (Bacillus), 101, 580, 663, 749, nebulosus (Bacterium), 699 nebulosus (Cryptococcus), 258 nebulosus (Protococcus), 258 nebulosus gazogenes (Bacillus), 749 necans (Bacillus), 663 necrodentalis (Bacillus), 361, 362 necrogenes (Bacillus), 579 necrogenes (Spherophorus), 579

necrophorum (Bacterum), 578
necrophorum (Corynebacterum), 578
necrophorus (Actinomyces), 578
necrophorus (Bacillus), 578
necrophorus (Fusiformis), 578, 583
necrophorus (Spherophorus), 578, 580, 583, 928

necrophora (Pasteurella), 554

necrophora (Streptothriz), 578, 977

oss, u29
necrosess (Eacilius), 529
necrosess (Bacilius), 579
necrosess (Streptococcus), 342
necroticus (Micrococcobaculius), 630
necroticus (Spherophorus), 579
necroticus (Spherophorus), 579
necroticus (Spherophorus), 342
nectarophila (Bacterium), 134
nectarophila (Phytomonas), 134
nectarophila (Phytomonas), 134
nectarophila (Pseudomonas), 134
nectarophila (Recilius), 544
negombensis (Bacilius), 544
negombensis (Shigella), 544
neigeux (Bacilius), 577
nesserv (Pacinia), 386

Neisseria, 19, 21, 26, 27, 29, 31, 33, 295 nelliae (Bacillus), 478 nelliae (Erwinia), 478 nenckii (Achromobacter), 624 nenckii (Bacterium), 624 neocistes (Vibrio), 199 neoformans (Micrococcus), 268 neotropicalis (Borrelsa), 1068 neotropicalis (Spirochaeta), 1064 neotropicalis (Treponema), 1064 nephriticus (Bacillus), 663 nephritidia (Bacterium), 553, 760, 761 nephritidis equi (Bacillus), 540 nephritidis instertitialis (Bacillus), 760 neptunium (Flavobacterium), 432 neritica (Peeudomonas), 699 nerviclarens (Marmor), 1198 neschezadimenki (Actinomyces), 928 neschezadimenki (Cohnistreptothrix), 928 neumannı (Bacillus), 681, 749 neurolyticus (Musculomyces), 1293 neurotomae (Bacillus), 663 neurotomae (Bacterium), 663 neurotomae (Micrococcus), 268 neusionica (Naumanniella), 834 neuvillei (Micrococcus), 268 neveuzi (Spirochaeta), 1059 nevenzi (Spironema), 1059 neveuxi (Treponema), 1059 neveuxii (Spiroschaudinnia), 1059 Nevskia, 7, 35, 829 new brunswick (Salmonella), 525 newington (Salmonella), 524 newport (Salmonella), 573 newportensis (Salmonella), 513 newport var. kottbus (Salmonella), 513 Newskia, 7, 12, 14 new york (Salmonella), 522 nexibilis (Bacillus), 148 nexibilis (Bacterium), 699 nexibilis (Pseudomonas), 143, 699 nexifer (Micrococcus), 896 ntcolateri (Bacterium), 682 nicolaters (Pacinia), 798 Nicollarerillus, 11, 763 nicollei (Aetinomyces), 921 nicollei (Bartonella), 1108

nicollei (Haemobartonella), 1198 nicollei (Nocardia), 921 nicolles (Spirochaeta), 1059 nicollei (Spironema), 1059 nicollei (Treponema), 1059 nicomosaicum (Phytorirus), 1164 nicotianae (Bacillus), 137 nicolianae (Erwinia), 137 nicotianae-tabaci (Phytomonas), 639 nicotianum (Bacterium), 682 nicolinobacter (Bacterium), 682 nicloinophagum (Bacterium), 682 nictomotorum (Bacterium), 613 niger (Actinomyces), 969 niger (Bacillus), 711 niger (Micrococcus), 247 nigra (Nocardia), 921 nigra (Streptothriz), 921, 931, 969, nigrescens (Bocillus), 749 nigrescens (Micrococcus), 268 nigrescens (Nigrococcus), 268 nigrescens (Sorangium), 1024 nigricans (Actinomyces), 972 nigricans (Bacillus), 749 nigrifaciens (Pseudomonas), 109 nigrificans (Actinomycrs), 972 negreficant (Bacellus), 711 mgrificans (Clostridium), 802 nigrificans (Oospora), 972 Augrococcus, 10 nigrofaciens (Micrococcus), 268 nigromaculans (Bacterium), 168 nigromaculans (Phylomonas), 168 nigromaculans (Xanthomonas), 168 nigrum (Calenabacterium), 368 nigrum (Sorangium), 1024 nigrum (Spirillum), 217 nimbelsus (Achromobacter), 425, 692 nit (Erro), 1251 niloese (Salmonella), 525 nemspressuralis (Erwinia), 472 ninas kohl-yalomoii (Grahamella), 1110 niotii (Bacteroides), 367 niosii (Eubactersum), 367 nipponica (Ricketteia), 1001 nipponica (Richettsoides), 1091 nilens (Bacillus), 663

nitens (Bacterium), 682 nitidus (Arthromitus), 1003 nitidus (Bacillus), 749 nitidus (Micrococcus), 269 nitri (Bacillus), 749 nitrificans (Achromobacter), 76 nitrificans (Bacillus), 76 nitrificans (Bacterium), 76 nutrificans (Micrococcus), 269 Nitrobacter, 9, 17, 20, 26, 29, 31, 74, 837 nitrobacter (Bacillus), 71 nitrobacter (Bacterium), 74 nstrobacter (Nstrobacterium), 74 Nitrobacterium, 74 Nitrocvstis, 75 nitrogenes (Actinomyces), 972 nitrogenes (Bocillus), 426 Natrogloga, 75 Nitromonas, 8, 9, 70, 74 Nitrosococcus, 29, 31, 71 Nitrosocvetis, 72, 73 Nitrosogloea, 73 Natrosomonas, 17, 20, 25, 29, 31, 70, 71, nitrosomonas (Bacterium), 70 Nitrosospira, 69, 71, 72 nitrosus (Micrococcus), 71 nitrosus (Nitrosococcus), 69, 71 nitrovorum (Achromobacter), 425 nitrovorum (Bocterium), 425 nutroxus (Bacıllus), 749 nivalis (Micrococcus), 269 nualis (Pseudomonas), 149 nuca (Actinomyces), 972 nuea (Beggiatoa), 989 nuea (Leptotrichia), 989 nirea (Sarcina), 293 nivea (Symphyothrix), 989 nivea (Thiothrix), 989, 995 nuea var terticillata (Thiothrix), 989 niteus (Micrococcus), 269 nuosum (Bacterium), 777 nobilis (Bacillus), 750 nocardi (Bacterium), 895 nocard: (Salmonella), 532

nocardia (Streptococcus), 319

Nocardia, 9, 892, 917, 923, 987, 974 nocardii (Actinomyces), 895 nocardii (Streptothriz), 895 noctifuca (Sarcina), 637 noctuarii (Escherichia), 491 noctuarum (Bacillus), 491 nocluarum (Proteus), 431 Nodofolium, 15, 17, 831 nodosa (Leptospira), 1077 nodosa (Spirochacta), 1976 nodosum (Bacterium), 404 nodosum (Corynebactersum), 401 nodosum (Rhizobium), 225 nodosum (Treponema), 1077 nodosus (Actinomyces), 583, 917, 1074 nodosus (Fusiformis), 583, 917 nodosus parvus (Bacillus), 401 noelleri (Spirochaeta), 1968 Noguchia, 532 noguchii (Eperthyrozoon), 1101, 1113 noguchii (Spirochaeta), 1038 noguchii (Treponema), 1053 nomae (Bacillus), 682 nomae (Bacterium), 632 nomae (Streptococcus), 312 nondiastaticus (Actinomyces), 972 nondiastaticus (Bacillus), 733, 731 nonfermentans (Bacillus), 787, 826 nonfermentans (Micrococcus), 269 non-hemolyticus I, II and III (Strepto-

coccus), 342
nonliquefaciens (Anylabacter), 771, 524
nonliquefaciens (Cladothriz), 953
non liquefaciens (Clastridium), 519
non liquefaciens (Clostridium), 519
nonliquefaciens (Horactla), 592
nonliquefaciens (Foundomonas), 95
nonpogenes (Bacillus), 772, 524
nonum (Flectridium), 793, 526
nordhafen (Vibrio), 193
normandi (Spirochaeta), 1068
normandi var carthaginenss (Spirochaeta), 1068
nosocomale (Treponema), 1038
nosocomale (Spirochaeta), 1038

nosocomiale (Treponema), 1038 nosocomialis (Spirochaeta), 1038 nothnageli (Clostridium), S21 notus (Vibrio), 703

novacaesareae (Streptomyces). 951 novellus (Thiobacillus), 79 Novillus, 11, 763 novum (Plectridium), 750 novus (Bacillus), 750 novyi (Bacıllus), 777 novyi (Borrelia), 1061 novyi (Cacospira), 1061 novyi (Clostridium), 777, 824 novyi (Spirochaeta), 1061 novyi (Spironema), 1051 novyi (Spiroschaudinnia), 1061 novyi (Treponema), 1061 novyi Type A (Clostridium), 777 novyi Type B (Clostridium), 778 novyi Type C (Clostridium), 778 nubile (Chromobacterium), 401 nubilis (Micrococcus), 269 nubilum (Bacterium), 404, 405 nubilum (Corynebacterium), 401

nubilus (Bacillus), 404 nucleatum (Fusobactorium), 682 nucleatus (Fusiformis), 682 nuclei (Micrococcus), 269 nucleophagus (Coryococcus), 1191 nucleophyllus (Bacillus), 639 nyborg (Salmonella), 533

nubilum var. nonum (Corynebacterium),

nubilum (Flavobacterium), 404

oahu (Salmonella), 532 obermeieri (Cacospira), 1059 obermeieri (Spirillum), 1059 obermeieri (Spirochaeta), 1059 obermeieri (Spironema), 1050 obermeieri (Spiroschaudinnia), 1059 obermeieri (Treponema), 1059 oblongum (Bacterium), 682 oblongus (Bacilius), 682, 750 oblongus (Micrococcus), 682 obscoenus (Micrococcus), 269 obscura (Pseudomonas), 699 obsti (Eubacterium), 367 obtusa (Holospora), 1122 obiusa (Spirochaela), 1068 obtusa (Spiroschaudinnia), 1068

nicollei (Haemobartonella), 1108 nicollei (Nocardia), 921 nicollei (Spirochaeta), 1059 nicollei (Spironema), 1059 nicolles (Treponema), 1059 nicomosascum (Phytorirus), 1164 nicotrange (Bacillus), 137 nicotiange (Erwinia), 137 nicottanae-tabaci (Phytomonas), 639 nicotranum (Bacterrum), 682 nicotinobacter (Bacterium), 682 nictoinophagum (Bacterium), 652 nictoingiorum (Baclerium), 613 niger (Actinomuces), 969 niger (Bacillus), 711 niger (Micrococcus), 247 nigra (Nocardia), 921 niora (Streptothrix), 921, 934, 969, nigrescens (Bacillus), 749 nigrescens (Micrococcus), 265 nigrescens (Naprococcus), 268 nigrescens (Sorangium), 1024 mioricans (Actinomyces), 972 ntericans (Bacillus), 749 nigrifaciena (Pseudomonas), 109 nigrificans (Actinomuces), 972 migrificans (Bacillus), 711 nigrificans (Clostridium), 802 nigrificani (Oospora), 972 Nagrococcus, 10 nigrofaciens (Micrococcus), 268 nigromaculans (Baclerium), 168 nioremaculans (Phytomonas), 168 nigromaculans (Xanthomonas), 168 nigrum (Catenabaclerium), 368 nigrum (Sorangium), 1024 nigrum (Spirillum), 217 nijibelsus (Achromobacter), 425, 692 mili (Erro), 1251 niloese (Salmonella), 525 nimipressuralis (Erwinia), 472 nınas kohl-yakomocı (Grahamella), 1110 niosii (Bacteroides), 367 niosit (Eubacterium), 367 nipponica (Ricketisia), 1091 nipponica (Rickettsoides), 1091 netens (Bacillus), 663

nitens (Bacterium), 682 nitidus (Arthromitus), 1003 netidus (Bacillus), 749 netidus (Micrococcus), 269 netra (Bacillus), 749 nstrificans (Achromobacter), 76 nstrificans (Bacillus), 76 nstrificans (Bacterium), 76 nitrificans (Micrococcus), 269 Natrobacter, 9, 17, 20, 26, 29, 31, 74, nitrobacter (Bacillus), 74 nitrobacter (Bacterium), 74 nstrobactes (Natrobacterium), 74 Natrobactersum, 74 Nitrocystis, 75 nitrogenes (Actinomyces), 972 netropenes (Bacillus), 426 Natrogloea, 75 Natromonas, 8, 9, 70, 74 Nitrosococcus, 29, 31, 71 Netrosocystis, 72, 73 Nitrosocloes, 73 Nitrosomonas, 17, 20, 25, 29, 31, 70, 71, 72, 73 nitrosomonas (Bacterium), 70 Natrosospira, 69, 71, 72 natrosus (Micrococcus), 71 nitrosus (Nitrosococcus), 69, 71 nitrovorum (Achromobacter), 425 nifrotorum (Bacterium), 425 nitroxus (Bacillus), 749 nivalis (Micrococcus), 269 nualis (Pseudomonas), 148 nices (Actinomyces), 972 nues (Beggiatoa), 989 nuca (Leptotrichia), 999 nirea (Sarcina), 293 nices (Symphyothrix), 983 nivea (Thiothrix), 989, 995 nered was verticillata (Thiothrix), 989 nneus (Mtcrococcus), 260 nisosum (Bactersum), 777 nobilis (Bocillus), 750 nocarde (Bacterium), 895 nocardi (Salmonella), 532 nocardia (Streptococcus), 319

Green fluorescent pigment produced in culture.

Gelatin: Liquefaction.

Agar colonies: Cream-colored to yellowish.

Broth: Turbid, with pelliele.

Milk · Alkaline. Soft curd at times. Nitrates are produced from nitrates. Not produced (Clara, loc. cit.)

Indole not produced.

No H2S produced.

Acid but not gas from glucose, galnetose, fructose, mannose, arabinose, xylose, rhamnose, mannitol and glycerol. Alkali from salts of acetic, citric, malic, formie, lactie, succinic and tartaric acid. Sucrose, maltose, lactose, raffinose and salicin not fermented (Clara, loc. cit.).

Starch hydrolysis fceble. None (Clara.

loc. cit.).

Optimum temperature 25° to 26°C. Maximum 38°C. Minimum 0°C.

Aerobic

Source: Isolated from marginal lesion on lettuce from Kansas.

Habitat: Pathogenic on lettuce and related plants

Pseudomonas setarlae (Okabe) comb. nov. (Bocterium setariae Okabe, Jour. Soc. Trop. Agr. Formosa, 6, 1934, 63: Phytomonas setariae Burkholder, in Bergey, Manual, 5th ed., 1939, 183.) From L. seta, bristle; -arius, like; M. L. Setaria, n generic name.

Rods: 0.4 to 08 by 1.8 to 4.4 microns. Motile with a polar, seldom bipolar, flagellum. Gram-negative.

Yellowish water-soluble pigment produced in culture.

Gelatin: Slow liquefaction.

Beef-extract agar colonies Circular,

white, opalescent, smooth, glistening. Broth: Turbid after 18 hours. Pel-

Milk: Alkaline; clears.

Nitrites are produced from nitrates. Indole is produced.

No H.S produced.

Acid but not gas from glucose, galac-

tose and glycerol. No acid from lactose. maltose or sucrose.

Starch: Feeble bydrolysis. Grows in 3 per cent salt.

Optimum temperature 31° to 34°C. Maximum 42°C.

Aerobic.

Source: Isolated from brown stripe of Italian millet.

Habitat: Pathogenic on Italian millet, Sctaria italica.

Pseudomonas polycolor Clara. (Clara, Phytopath., 20, 1930, 704; Phytomonas polycolor Clara, ibid., Bacterium polycolor Burgwitz, Phytopathogenic Bucteria, Leningrad, 1935, 148.) From Gr. poly, many; L. color, color.

Note: Delacroix (Comp. rend. Acad. Sci., Paris, 137, 1903, 454) describes Bocillus ocrogenosus as being a tobacco pathogen. The organism described by Delacroix might be the same as Pseudomonas polycolor. Braun and Elrod (Jour. Baet., 45, 1942, 40) are of the opinion that Clara's pathogen is Pseudomonas peruginoso.

Description taken from Clara (Cornell Agr. Exp. Sta. Mem. 159, 1934, 28).

Rods: 0.75 to 1.2 by 1.05 to 3.0 microns. Motile with I or 2 polar flagella. Gramnegative.

Green fluorescent pigment produced in culture.

Gelatin: Liquefaction. Beef-extract agar colonies: Grayishwhite, circular, raised, thin transparent murgins.

Broth: Turbid in 36 bours with thin pelliele.

Milk: Alkaline; no curd.

Nitrites not produced from nitrates

Indole not produced. Nn H.S produced.

Lipolytic (Starr and Burkholder, Phy-

topath., \$2, 1942, 601). Acid but not gas from glucose, galactose, fructose, mannose, arabinose, xy-

lose, mannitol and glycerol. Alkaline reaction from salts of acetic, citric, malic,

i

obtusum (Treponema), 1063 oceanica (Pseudomonas), 699 ocello cuneatum (Bacterium), 776 ochracea (Beggiatoa), 984 ochracea (Chlamydothrix), 984 ochracea (Lampropedia), 811 ochracea (Leptothriv), 984, 985, 986 ochracea (Lyngbya), 984 ochracea (Melosira), 831 ochracea (Merismopedia), 811 ochracea (Pseudomonas), 175, 699 ochraceum (Bactersum), 761 ochraceum (Chromobacterium), 175 ochraceum (Flavobacterium), 175 ochraceum (Polyangium), 1030 ochraceus (Actinomyces), 972 ochraceus (Bacillus), 175 ochraceus (Bactersum), 699 ochraceus (Cellvibrio), 210 ochraceus (Micrococcus), 269 Ochrobium, 835 ochroleuca (Pseudomonas), 148 ochrolsucus (Actinomyces), 972 ochroleucus (Bacillus), 663 ochroleucus (Micrococcus), 269 ochrolsucus (Planococcus), 269 ochroleucus (Streptococcus), 269 Octopsis, 546 oculogenitale (Chiamydozoon), 1115 oculorum (Leptothrix), 970 odontolyticus (Bacillus), 363 odontolyticus (Lactobacillus), 363 odoniolyticus (Streptococcus), 342 odorans (Proteus), 491 odorałum (Bacterrum), 664, 739 odoratus (Bacsllus), 663, 664, 739 odoratus (Micrococcus), 269 odorifer (Actinomyces), 974 odorifera (Actinomyces), 972 odorifera (Cladothrix), 934, 974 odorifera (Nocardia), 974 odorifera (Oospora), 974 odorifera (Streptothriz), 974 odoreficans (Bacellus), 664 odorificus (Bacillus), 684 odorus (Bacillus), 664 odorus (Macrococcus), 269

ocdematiens (Bacillus), 777, 825
ocdematiens (Clostridium), 777
ocdematiens (Clostridium), 777
ocdematis (Bacillus), 757
ocdematis (Bacillus), 757, 782, 815
ocdematis benipni (Clostridium), 818
ocdematis maligni (Bacillus), 775, 782, 815
ocdematis maligni (Clostridium), 775, 782
ocdematis maligni No. 11 (Bacillus), 775, 782
ocdematis maligni No. 17 (Bacillus), 787, 826

oedematis thermophilus (Bacillus), 777 oedematis thermophilus (Bacterium), 777 oedematogenes (Bacillus), 818 oedematordes (Clostridium), 787, 826 ochenses (Bacillus), 750 ogatac (Bacterium), 682 ordieformis (Streptothriz), 977 okeanokoites (Flavobacterium), 429 ohenii (Bacıllus), 857 okenii (Bacterium), 857 okenii (Chromatium), 852, 854, 856, 857 okenii (Monas), 857 okenii (Pseudomonas), 857 oleae (Bacellus), 132, 750 oleae (Bacterium), 132 oleae tuberculosis (Bacillus), 132 oleracea (Erwinia), 470 oleraceus (Bacillus), 470 olearius (Micrococcus), 269 olens (Micrococcus), 269 olens, (Sarcina), 293 olcovorans (Pseudomonas), 95 olfactorius (Bacillus), 718 oligoacidificans (Lactobacterium), 363 oligocarbophila (Carbozydomonas), 972 oligocarbophilus (Actinomyces), 972 oligocarbophilus (Bacillus), 972 oligocarbophilus (Proactinamyces), 923, oligotrophum (Nirobacter), 76

olivaceus (Actinomyces), 950 olivaceus (Streptomyces), 950 olivac (Bacterum), 750, olivac (Bacterum), 751 olivochromogenus (Actinomyces), 911 olivochromogenus (Beteptomyces), 941 ometianskri (Bactilus), 750, 800

orangea (Sarcina), 293

omehanskii (Clostridium), 808, 809 orangica (Nocardia), 976 omelianskii (Methanobacterium), 645, orangica (Streptothrix), 976 646, 795, 820 orangico-niger (Actinomyces), 972 Omelianskillus, 11, 763 orangicus (Actinomyces), 972 omnivorus (Bacillus), 470 orangium (Chromobacterium), 694 onarimon (Salmonella), 519 oranienburg (Salmonella), 510 oncidii (Bacıllus), 640 oranienburgensis (Salmonella), 510 oncidii (Bacterium?), 640 orbicularis (Micrococcus), 270 oncidii (Phytomonas?), 640 orbicularis flavus (Micrococcus), 270 onderstepoort (Salmonella), 528 orbiculata (Neisseria), 300 onlarioni (Bacillus), 750 orbiculatus (Micrococcus), 270 ontarioni (Bacterium), 750, 759 orbiculus (Diplococcus), 300 oogenes (Bacillus), 750 orchiticum (Bacterium), 682 oogenes fluorescens a (Bacillus), 150 orchiticus (Bacıllus), 683 oogenes fluorescens # (Bacillus), 147 orchitidis (Flavobacterium), 556 oogenes fluorescens y (Bacillus), 149 oregon (Salmonella), 513 oogenes fluorescens & (Bacillus), 149 orenburgii (Bacıllus), 352 oogenes fluorescens e (Bacillus), 149 orientale (Bacillus), 362 oogenes hydrosulfureus a (Bacillus), 750 orientalis (Dermacentrozenus), 1000 oogenes hydrosulfureus \$ (Bacillus), 147 orientalis (Nanus), 1206 oogenes hydrosulfureus y (Bacillus), 672 orientalis (Rickettera), 1089, 1090 oogenes hydrosulfureus & (Bacellus), 148, orientalis (Salmonella), 528 663 orientalis var. schüffneri (Richettsia), oogenes hydrosulfureus « (Bacillus), 663 1000 cogenes hydrosulfureus : (Bacillus), 663 orientum (Propionibacterium), 379 oogenes hydrosulfureus x (Bacillus), 654 orion (Salmonella), 524 orleanense (Bacterium), 187, 693 oogenes hydrosulfureus > (Bacillus), 653 oogenes kydrosulfureus s (Bacillus), orleanensis (Ulvina), 693 ornithopi (Bacillus), 224 659 ornithosis (Miyagawanella), 1117, 1118, oogenes (Pseudomonas), 148 conergasius (Bacillus), 664 1119 ornheus (Bacillus), 724 opaca (Nocardia), 897 orthobutylicus (Bacillus), 771, 824 opacum (Mycobacterium), 897 orthodonta (Spirochaeta), 1075 opacum (Nitrobacter), 76 orthodontum (Treponema), 1075 opacus (Bacillus), 750 oruzae (Bacterium), 168 opacus (Proactinomyces), 897, 898 oryzae (Fractilinea), 1160 opacus (Streptococcus), 342 oryzae (Marmor), 1160 opalanitza (Leuconostoc), 346 oryzae (Phytomonas), 163 opalescens (Micrococcus), 252, 270 oruzae (Pseudomonas), 168 Ophidomonas, 6, 850 oryzae (Xanthomonas), 168 Ophiocystia, 14, 1017 Oscillatoria, 988, 991, 1007 opossum (Bartonella), 1103 Oscillospira, 1004 opossum (Haemobartonella), 1108 oslo (Salmonella), 511 opportunus (Streptococcus), 342 osteomyeliticus (Bacıllus), 664 orae (Annulus), 1155, 1212, 1213 (Bacitlus). osteomyelitus bubalorum oras (Bacıllus), 750 778 orae (Tractus), 1213

osteophilum (Bacterium), 683

ostreae (Cristispira), 1056 ostreae (Spirillum), 217 ostreae (Spirochaeta), 1056 ostrei (Bacillus), 532 ostrei (Salmonella), 532

otitidis sporogenes putrificus (Bacillus),

oralis (Bacterium), 441
oralis (Micrococus), 270, 325, 326
ovalis (Pseudomonas), 97, 639
ovalis (Streptococcus), 325
ovalisporus (Myvococcus), 1043, 1044

ovaiisportis (Alyxococcus), 1023, 104 ovata (Pasteurella), 572 ocatum (Bacterrum), 683 ocatum (Panhistophyton), 254

ovatus (Bacteroides), 572, 577
ovatus (Micrococcus), 234
ovatus minulissimus (Bacillus), 683

ocatus (Micrococcus), 234
ocatus minulissimus (Bacillus), 683
ocatus minutissimus (Bacterium),
683

683
ort (Pseudomonas), 149
ort cola (Pseudomonas), 149
ort cola (Pseudomonas), 149
ort cola (Pseudomonas), 130
ortforms (Backerodes), 353
ortforms (Backerodes), 353
ortforms (Coccobacillus), 333
ortforms (Coccobacillus), 333
ortforms (Coccobacillus), 1003
ortforms (Spirotchaud), 1003
ortforms (Spirotchaud), 1003
ortforms, 1503
ortforms, 1503
ortforms, 1504

ovinum (Bacterium), 554 ovinum (Treponema), 1068 ovis (Corynebacterium), 62, 389, 694 ovis (Cperythrozoon), 1112

oris (Hemophilus), 589 oris (Listerella), 403 oris (Micrococcus), 267

ovis (Spirillum), 1068

ovis (Spirochaeta), 1008 ovis (Spironema), 1068 ovis (Streptococcus), 342 ovis (Tortor), 1278

ovis (Torior), 1215
ovis (Treponema), 1068
oviseptica (Pasteurella), 554

oritoxicus (Bacillus), 790 oritoxicus (Clostridium), 790, 826 oritoxicus (Welchia), 790

oroaethylicus (Bacillus), 720 oxalaticus (Bacillus), 714, 750

oxaliferum (Achromatium), 996, 997,

oxydans (Acetobacter), 184 oxydans (Bacillus), 182, 184

oxydans (Bacterium), 184 oxygenes (Bacterium), 544 oxygenes (Eberthella), 544 oxygenes (Shigolla), 544

oxygenes (Shigella), 514 oxylacticus (Bacillus), 664, 750 oxylacticus (Bacierium), 750 oxyphila (Eberthella), 534

oxyphilam (Bacterium), 534 oxytocum (Aerobacter), 456 oxytocum (Bacterium), 456

oxytocus (Bacıllus), 456 oxytocus (Escherichia), 456

oxytocus perniciosus (Bacillus), 456 oxytocus perniciosus (Bacterium), 456

ozaenae (Bacillus), 459, 658 ozaenae (Bacterium), 459 ozaenae (Klebsiella), 459

ozaenae (Liebsiella), 459 ozenae (Encapsulaia), 459 pabuli (Bacillus), 750

patuli (Placamobacterium), 693 patuli (Placamobacterium), 693 patuli acudi II (Bartilus), 356, 983 patuli acudi (Lactobacillus), 356 pachetabrae (Cristiprea), 1056 pachetyhia (Lalarmot), 1188 Pacnia, 102, 249, 763 praglami (Bacillus), 656, 804 praglami (Clotindium), 801 paglami (Edeotyporus), 801

paleopneumoniae (Diplococcus), 309 paleos (Bacterium), 683

pullens (Micrococcus), 270
pullens (Streptococcus), 342

parabotulinus (Bacillus), 779, 780 parabotulinus bovis (Clostridium), 77 parabutyrieus (Bacillus), 813, 816 naracifroporus (Streptococcus), 347 para-coagulans (Bacillus), 532 para-congulans (Salmonella), 532 Paracloster, 7, 705 paracoli (Bacterium), 460 Paracolobactrum, 460, 461, 489 para-colon (Bacillus), 460 para-colon (Salmonella), 460 varadifficens (Bacillus), 491 paradiffluens (Proteus), 491 paradoxa (Escherichia), 453 paradoxus (Bacillus), 683 paradoxus (Bacterium), 683 paradoxus (Colibacillus), 453 paradysenteriae (Bacıllus), 537, 538 paradysenteriae (Bacterium), 537 paradysenteriae (Eberthella), 537 paradysenteriae (Shigella) 537, 539, 839, 540, 543 paradysenteriae Type Manchester (Shigella), 539

paradysenteriae (Type Newcastle) (Shigella), 538

paradysenteriae var. sonnes (Skagella),

540 paradysenteriae X (Bacillus), 536 paraenterica (Enteroides), 452 paraenterica (Escherichia), 453 paraentericus (Bacıllus), 453 paraexilis (Bacillus), 352 paraffinae (Micrococcus), 270 paraffinae (Nocardia), 901 paraffinae (Proactinomyces), 901 para-gruenthali (Bacıllus), 451 paragruenthali (Cecherichia), 451 paraguayensis (Proactinomyces), 923 parainfluenzae (Hemophilus), 585, 585 paralacticus (Streptococcus), 321 parallela (Aphanothece), 872 parallela (Pediochloris), 872 parallelum (Pelodictyon), 872 parallelus (Bacillus), 661 paraluis (Spirochaeta), 1073 paraluis cuniculi (Spirochaeta), 1073

paralytica (Klebsiella), 459 paralyticans (Bacillus), 405 paralyticans (Corynebacterium). 405 paramecu (Müllerina), 1122 paramelitensis (Brucella), 563 paramelitensis (Micrococcus), 563 paramorganii (Proteus), 491 paraoxylocum (Aerobacter), 456 para-pertussis (Bacillus), 587 Paraplectrum, 7, 33, 763 paraputrificum (Clostridium), 793 paraputrificum (Plectridium), 793 paraputrificus (Bacellus), 793 paraputrificus (Tissierillus), 793 paraputrificus coli (Bacillus), 793 parasarcophysematos (Bacillus), 775 parasitica (Leptothrix), 366 parasiticum (Bactersum), 368 parasiticum (Polyangium), 1032 Paraspirillum, 0 parasporogenes (Bacillus), 784 parasporogenes (Clostridium), 784 parasus (Brucella), 563 paratuberculosis (Mycobacterium), 881 paratuphs (Bacillus), 501 paratyphi (Bacterium), 501 paratyphi (Salmonella), 495, 501 paratyphs abortus avis (Bacillus), 506 paratyphs alcaligenes (Bacillus), 501 paratuphi alver (Bacellus), 532 paratyphi A (Salmonella), 493, 501 paratyphs B (Salmonella), 493, 501 paratyphs C (Salmonella), 493, 507 paralyphi Typus A (Bacterium), 501 paratyphi, Typus B (Bacterium), 501 paratyphosum A (Bacterium), 501 paratyphosum B (Bacterium), 501 paratyphosus (Bacillus), 501 paratyphosus A (Bacillus), 501 paratyphosus B (Bacellus), 501, 509 paratyphosus B, (Bacillus), 507 paratyphosus B, Arkansas type (Bacillus). 503 paratyphosus B, Binus type (Bacellus), paratyphosus B, Mutton type (Bacillus) 502

paratyphosus B, Newport type (Bacillus). paratyphosus B, Reading type (Bacillus.) paratyphosus B, Stanley type (Bacillus), 503 paratyphosus C (Bacillus), 507, 509 paratyphosus C (Salmonella), 507, 509 paraviscosum (Bacterium), 683 parcifermentans (Lactobacterium), parkers (Borrelia), 1064 parkeri (Spirochaeta), 1064 parotitidis (Micrococcus), 270 parotitidis (Spirochaeta), 1074 partum (Clostridium), 821 parva (Cornilia), 822 parva (Micromonospora), 979 parva (Nocardia), 939 parvula (Cristispira), 1056 parvula (Veillonella), 302, 303, 304 parvula var. branhamii (Veillonella), 303 parvula yar. minima (Veillonella), 303 parvula var. thomsonii (Vcillonella). 303 parvulum (Bacterium), 642 parvulum (Corynebacterium), 40S parvulus (Micrococcus), 302 parvulus (Staphylococcus), 302, 345 parvulus (Streptococcus), 331, 342 parvulus (Streptostaphylococcus), 345 parvulus non liquefaciens (Streptococcus),

parvum (Bacterium), 822 parvum (Corynebacterium), 388, 405 parvum (Eubacterium), 368 parcum (Spirillum), 203, 701 parvum (Spirochaeta), 1075 parvum (Treponema), 1075 parvum infectiosum (Corynebacterium). 405 parvus (Actinomyces), 939 parvus (Bacillus), 544, 712 parvus (Jodococcus), 270, 695 parvus (Micrococcus), 270 parvus (Phagus), 1131 parvus (Rhodovibria), 863

parvus (Streptomyces), 939

parvus (Vibrio), 203 parvus liquefaciens (Bacillus), 404 parvus oratus (Bacillus), 548 passeti (Staphylococcus), 236 passiflorae (Marmor), 1193 passiflorae (Phytomonas), 138 passiflorae (Pseudomonas), 138 Pasteurella, 17, 21, 22, 26, 32, 37, 42, 516, 551, 577, 1290 pasteuri (Cornilia), 775 pasteuri (Micrococcus), 270, 306 Pasteuria, 35, 836 pasteuriana (Ulvina), 692 pasteurianum (Acetobacter), 61, 180, 182,692 pasteurianum (Bacıllus), 692 pasteurianum (Bacterium), 182 pasteurianum (Clostridium), 772, 824 pasteurianum (Mycoderma), 182 pasteurianum (Rhyzobium), 225 parleurianus (Bacilius), 772 pasteurii (Bacıllus), 729, 741 pasteurii (Urabacıllus), 729 pasteurii (Vibrio), 774 pastinator (Achromobacter), 528 pasterianum (Clostridium), 772 pastorianum (Lactobacterrum), 300 pastorianum (Plocamobacterium), 695 pastorianus (Bacillus), 359, 772 pastorianus (Lactobacillus), 359, 695

haro-

y ..... bacıllus), 360 patelliforme (Bacterium), 683 pateriforme (Bacterium), 683 pathogenicum (Photobacterium), 635 paucicutis (Bacillus), 750 paullulus (Bocillus), 661 pauloensis (Eberthella), 534 pauloensis (Escherichia), 453 pauloensis (Salmonella), 532 Paulosarcina, 13, 285 1 - m) 332. paroninus (Bacıllus), 233 paronis (Treponema), 1075 pecoris (Hostis), 1239 \_ pectinis (Cristispira), 1056 Pectinobacter, 763 pectinophorde (Bacillus), 661 pectinocorum (Aerobacter), 456 nectinovorum (Bacillus), 822 pectinovorum (Clostridium), 771, 822 pectinovorum (Granulobacter), 771, 523 peclinororum (Plectridium), 771, 822. 824 pectinovorum liquefaciena (Plectridium), pectinovorus (Bacillus), 522 Pectobacellus, 8, 763 Pectobacterium, 464 pectocutis (Bacillus), 750 pediculata (Nevalia), 830 pediculatum (Bacterium), 830 pediculatus (Chondromyces), 1038 pediculi (Bacillus), 664 pediculi (Rickettina), 1004, 1095, 1096, 1007 Pediochloris, 870 Pediococcus, 7, 25, 235, 249, 844 Pedioplana, 235, 250 pelagia (Bacillus), 635 pelania (Bacterium), 635 pelagia (Sarcina), 701 pelagreus (Bacillus), 750 pelamídis (Spirochaeta), 1068 pelamidis (Spironema), 1068 pelargoni (Bacterium), 160 pelargoni (Pseudomonas), 160 pelargonii (Marmor), 1199 pelargonsi (Phytomonus), 160 pelargonii (Xanthomonas), 160, 167 pelletteri (Actinomyces), 960 pelletieri (Discomyces), 960 pelletieri (Micrococcus), 900 pelletieri (Nocardia), 960 pelletteri (Oospora), 960 pelletieri (Streptomyces), 960 pelliculosa (Pseudomonas), 149 pellucida (Beggiatoa), 992 pellucida (Pseudomonas), 149

nellucidum (Achromobacter), 145 pellucidum (Halibacterium), 653 pellucidus (Bacillus), 661, 750 pellucidus (Aficrococcus), 270 Pelochromatium, 859 Pelodictyon, 870 pelogenes (Actinomyces), 972 Pelonloca, 870 pelomyxae (Cladothrix), 1123 pelurida var virginiana (Pseudomonas). pemphigi (Micrococcus), 270 pemphigi acuti (Diplococcus), 270 pemphigi contagiosa (Micrococcus), 270 pemphiai neanatorum (Micrococcus), 271 pemphigi neonatorum (Staphylococcus), pendens (Rhodothece), 855 pendunculatus (Bacıllus), 741 penicillatus (Bacillus), 816 penortha (Smrochaeta), 583, 917, 1074 pensacola (Salmonella), 518 pentoaceticum (Plocamobacterium), 695 pentoaceticus (Laciobacillus), 358, 695 pentoaceticus var magnus (Lacto. bacillus), 358 pentosaceum (Propionibacterium), 378, 379 pentosaceus (Pediococcus), 250 pentosus (Lactobacellus), 357 pepo (Bacillus), 730 Peptoclostridium, 30, 763 Pentococcus, 29, 30 peptogenes (Bacillus), 751 peplogenes (Bactersum), 751 peptonana (Bacillus), 751 peptonificans (Bacillus), 751 Peptonococcus, 235 Peptostreptococcus, 30, 31, 312 perentreus (Micrococcus), 271

percolans (Vibro), 201

perexile (Treponema), 1075

perexilis (Spirochaeta), 1076

perflava (Nesseria), 298

perflucus (Micrococcus), 271

perekropori (Eperythrozoon), 1113

perfectomarinus (Pseudomonas), 699

312

perolens (Achromobacier), 425

perfoctens (Bacterium), 576 perfoetens (Bocteroides), 576 perfoctens (Ristella), 576 perforans (Spirochaeta), 1065 verfringens (Bacillus), 700, 815, 829 perfringens (Clostridium), 789, 700, 817. \$18, \$20 perfringent Type A (Closteidium), 789 perfringens Type B (Clostridium), 790 perfringens Type C (Clostridium), 700 perfringens Type D (Closteidium), 700 perfringent (Welchia), 790 perfringens var. anaerogenes (Clostridium), 791, 826 perfringent var. egens (Clostridium). 790 perfringens var. egens (Welchia), 790 perferngens var, soodyzenterioe (Welchia). 791 persentativa (Pasteurella), 651 pericoma (l'ibrio), 205 perimastrix (Vibrio), 703 periphyta (Pseudomonas), 699 periplanetae (Corunebacterium), 403 periplanetae (Spirochaeta), 1063 periplanetge var. americana (Corunebacterium), 103 periplaneticum (Spirillum), 217 peripneumoniae (Borrelomyces), 1231 peripneumoniae (Mycoplasma), 1291 peripheumaniae boris (Asteromyces), 1291 peripneumonioe boris contagiosae (Mieromyecs), 1231 peritonitidia (Streptococcus), 317 perstantisdis equi (Streptococcus), 317 peritonitis (Spherophorus), 579 perittomatieum (Bocterium), 761 perlibrotus (Bacillus), 661 perlucidulus (Bacıllus), 751 perlurida (Cellulomonas), 174 perlurida (Pseudomonas), 174 perniciosus (Microcoecus), 312 perniciosus (Pedrococeus), 250 perniciosus (Streptococcus), 342 permiciosus psittacorum (Streptococcus),

peromyses (Grahamella), 1111 peromysei (Hacmobartonella), 1106 peromysci var. moniculati (Grohamello), peromysci var. maniculati (Haemobar. tonella), 1106 peroniella (Bacillus), 816 peroxydans (Acetobacter), 189 perroneiti (Bacillus), 661 Perroncitoo, 312 persica (Borrelia), 1000 persica (Spirochaeta), 1069 presicae (Chlorogenus), 1143, 1152 persicae (Flavimocula), 1196 persicae (Marmor), 1196, 1202 persicae var. micropersica (Chlorogenus), persicae var. rulgaris (Chlorogenus). 3149 persicina (Palmella), 818 persicina (Sorcina), 203 persicum (Treponemo), 1069 persicus (Micrococcus), 271 pertenue (Spironema), 1071 pertenue (Treponema), 1071 perlenuis (Spirocharta), 1071 pertussis (Bacillus), 586, 737 pertussis (Hemophilus), 586, 587, 589 pertussis eppendorf (Bacillus), 559 peruriana (Bartonella), 1101 pestifer (Achromobocter), 425 pestifer (Bacillus), 425 pestifer (Bacterium), 425 pertis (Borillus), 519 pestis (Bacterium), 519 pestis (Eucystia), 519 pestis (l'asteurella), 549, 703 pestis bubonicos (Bacillus), 519 pestis bubonicoe (Bacterium), 519 pestis cariae (Bocillus), 502 pestis carine (Posteurella), 503 petasites (Bocillus), 714 petasitis (Bacterium), 142 petasitis (Phytomonos), 142 petasitis (Pseudomonas), 142 pelechialis (Micrococcus), 271 petersii (Bacillus), 601

```
petersii (Bacterium), 683
peterssonii (Propionibaeterium). 376
netilus (Micrococcus), 271
natiolatus (Racillus) 751
netit (Spirochaeta) 215
netrolei (Microenceus), 271
netroselini (Racillus), 715
neteoselini (Racterium), 715
nettiti (Leptosmra), 1079
peltili (Spirochaeta), 215, 1079
 pettiti (Trenonema), 1079
 nfafi (Bacillus), 539
 plaffii (Bacterium), 539
 pfaffii (Eberthella), 539
 nfaffii (Shirella), 539
 Pfeifferella, 9, 21, 22, 23, 554
 pfeifferi (Coccobacillus), 585
 nfeiffers (Encansulatus), 459
                                (Bacellus).
 nfisomones-emphysematosae
 nfleamones-emphysematosae (Clastridium).
   700
  nflateri (Arthrohoeterrum), 635
  pflügeri (Bacterium), 635
  pflügeri (Micrococcus), 635
  pflügeri (Photobacterium), fil5
  Phocelium, 13, 285
  phaeochromogenus (Actinomuces), 913
  phseochromogenus (Streptomyces), 943
  Phaeomonas, 29, 30
  Phaeospirillum, 29, 30, 866
  phacedenis (Borrelia), 1964
  .1 1, , , , , , , , , , , , , , , , ,
   pharynais (Diplococcus), 209
   pharynoss (Micrococcus), 696
   pharynais (Neisseria), 209, 696
   pharyngis (Staphylococcus), 282
   pharyngis cinerea (Neisseria), 298
   pharyngis cinereus (Micrococcus), 298
   pharyngis communis (Diplococcus), 238
```

pharnygis flavus I (Diplococcus), 218

pharyngs flarus II (Diplococcus), 229

phoremois flavus I (Micrococcus), 299 pharmais flavus II (Micrococcus), 299 nharunais-sicci (Neisseria), 208 phorumous siecus (Dintococcus) 208 pharmais succus (Micrococcus). 298 phaseals (Racillus) 160 751 nhasenis (Bacterium), 160 nhazenti (Phytomonas), 160 nhaseols (Pseudomonas), 160 phascoli (Marmor), 1168, 1179 phascoli (Rhisobium), 225, 226 phesoale (Xenthamones), 160, 161, 1134. phaseols var. fuscans (Bacterium), 161 phaseoli var, fuscans (Phytomonas). 161 nhaseols var. fuscans (Pseudomonas). 161 phaseols var. (useous (Xanthomonas), 161 phaseols var sosense (Bactersum), 161 phaseoli var. soiense (Phytomonas), 161 phaseols var. sojensis (Xanihomonas), 161 phaseolicola (Pseudomonas), 118 phasiani (Bacıllus), 520 phasiant septicus (Barillus), 520 phasians senticus (Bacterium), 520 phaseanicida (Bacillus), 552 phasianicida (Bacterium), 552 phasianidarum mobile (Bacterium), 552 phenanthrenseus bakiensis (Bacillus), 664 phenanthrenicus guricus (Bacillus), 665 phenologenes (Bacillus), 665 phenolphilos (Bacillus), 751 phenotolerans (Actinomuces), 917 phiebotoms (Spirochacia), 1074 phlegmones emphysematosae (Bacillus). 789, 790, 826 phlei (Mycobacterium), 881, 887, 889, -11- 10-1- 11 · ora . 890 · meromation, is, as pholas (Bactersum), 635 phormicola (Bacterium), 166

pharmicola (Phytomonas), 168

phosphorescens (Bacillus), 111

phormicola (Xanthomonas), 166

633.

phosphorescens (Bacterium), 111, 633. 635, 636 phosphorescens (Micrococcus), 633 phosphorescens (Microspira), 700 phosphorescens (Pasteurella), 609 phosphoreseens (Photobacterium). 635, 636 phosphorescens (Pseudomonas), 111, 699 phosphorescens (Spirillum), 633 phosphorescens (Vibrio), 633, 702 phosphorescens gelidus (Bacillus), 636 phosphorescens gelidus (Bacterium), 635 phosphorescens giardi (Bacillus), 635 phosphorescens giardi (Bacterium), 635 phosphorescens indicus (Bacillus), 699 phosphorescens indicus (Bacterium), 699 phosphorescens indigenus (Bacillus), 633 phosphorescens indigenus (Bacterium), 633. 636 phosphorescens pflugers (Bactersum), 633 phosphoreum (Achromobacter), 634 phosphoreum (Bacterium), 633, 635, 636, 637 phosphoreum (Microspira), 636 phosphoreum (Photobacter), 633 phosphoreum (Photobacterium), 633 phosphoreus (Bacillus), 633, 634 phosphoreus (Micrococcus), 633, 635 phosphoreus (Streptococcus), 633 phosphoricum (Achromobacter), 631 phosphoricus (Bacillus), 634 Photobacter, 636 Photobacterium, 12, 14, 192, 636 photometricum (Bacterium), 683 photometricum (Rhodospirillum), 867 photometricus (Bacillus), 683 Photomonas, 11, 636 Photospirillum, 636 photures (Proteus), 491 Phragmidiothrix, 6, 12, 17, 19, 987 phyllotidis (Grahamella), 1111 physiculus (Micrococcus), 636 Phytomonas, 31, 32, 150 Phytomyxa, 223 phylophthora (Erwinia), 469, 470 phytophthorum (Bacterium), 470 phytophthorum (Pectobacterium), 470

picrogenes (Bacillus), 751 picrum (Achromobacter), 622 pictor (Treponema), 1072 pictorum (Achromobacter), 177 pictorum (Pseudomonas), 177 pierantonii (Bacillus), 202 pierantonii (Cocco-bacillus), 112 pierantonii (Micrococcus), 112 pierantonii (Pseudomonas), 112 pierantonii (Vibrio), 202 pieridis (Micrococcus), 271 pieris (Borrelina), 1227 pieris (Diplobacillus), 600 picris (Diplococcus), 336 picris (Vibrio), 703 pieris agilis (Bacillus), 665 pieris fluorescens (Bacillus), 665 pieris Louefaciens (Bacıllus), 665 pieris liquefacions a (Bacillus), 665 pieris liquefacions \$ (Bacillus), 665 pieris liquefaciens (Bacterium), 665 pieris non-liquefaciens a (Bacillus), 605 pieris non-liquefaciens B (Bacillus), 665 piesmae (Savoia), 1221 prima (Streptococcus), 312 puppers (Actinomyces), 921 puperi (Discomyces), 921 pippers (Nocardia), 921 pikowsky: (Achromobacter), 425 pikowskyi (Micrococcus), 271 piliformis (Bacillus), 366, 751 piliformia (Micrococcus), 271 piltonensis (Micrococcus), 211 piluliformans (Bacillus), 684 piluliformans (Bacterium), 683 pini (Bacterium), 640 pini (Pscudomonas), 640 pinnae (Cristispira), 1055 pinnae (Spirochaete), 1055 punnatum (Achromobacter), 425 pinnatus (Bacıllus), 425 punnatus (Bactereum), 426

phylophthorus (Bacillus), 469, 470

lactic and formic acid. Rhamnose, sucrose, maltose, lactose, raffinose and salicia not formented.

Starch not hydrolyzed.

Facultative anaerobe.

Good growth in broth plus 7 per cent salt.

Optimum temperature 25° to 30°C

Distinctive character. Differs from Pseudomonas mellea in type of lesion produced, does not digest starch, nor reduce altrates and does not form acid from lescos nor sucrose. Pathogenie for laboratory animals (Elrod and Braun, Sci. 94, 1941. 520).

Source: Repeatedly isolated from leaf spot of tobacco in the Philippines.

Habitat: Pathogenic on tobacco

99. Pseudomonas virldiflava (Burkholder) Clara (Phylomonas virldiflava Burkh, Cornell Agr. Evp. Sta Mem 127, 1999, 63; Clara, Science, 75, 1934, 111; Bacterium sirudiflavum Burgwitz, Phytopathogenic Bacteria, Leningtad, 1935, 127, From Latin viridis, green; flavus, yellow.

Description from Clara (Cornell Agr. Exp. Sta. Mem. 139, 1934, 30).

Rods. 0 75 to 1 5 by 1.5 to 3.15 microns. Motile with 1 or 2 polar flagella. Gramnegative.

Green fluorescent pigment produced in culture.

Gelatin · Liquefaction.

Beef-extract agar colonies Grayishwhite, margins corrugated, edges irregular.

Broth: Turbid in 36 hours.

Milk: Becomes alkaline and clears. Nitrites not produced from nitrates Indole not formed.

No H.S produced.

Not lipolytic (Starr and Burkholder, Phytopath , 52, 1942, 601).

Acid but not gas from glucose, fructose, mannose, arabinose, vylose, mannitol and glycerol. Alkaline reaction from salts of acetic, citric, malic, lactic and succinic acids. Sucrose, lactose, maltose, raffinose, salicin, and salts of formic and tartaric neids not fermented.

Starch: No hydrolysis.

Growth in broth plus 5 per cent NaCl

Facultative anaerobe.

Source: Two cultures isolated from spotted beans, one from England and one from Switzerland.

Hahitat. Pathogenie on bean, Phaseolus sulgaris.

99a Pseudomonas viridifiara var concentraca (Peterson) comb. nov. (Phylomonas viridifiara var. concentrica Petersen, Tridaskr f. Intancavi., 53, 1932, 851, Bacterium viridifiarum var concentricum Burgartz, Phytopathogenic Bacteria, Loningrad, 1935, 1271, From M. L. concentricus, concentric, referring to the rings on the colonies

Distinctive characters: Differs from Pseudomonas viridifiava in that it does not grow in Uschinsky's solution, and also in the shape of the colonies.

Source Isolated from the stems and leaves of blighted beans in Denmark.

Habitat. Pathogenic on the bean,

100. Pseudomonas ananas Serrano (Serrano, Philipp. Jour. Sci, 55, 1934, 255; Phytomonas ananas and Bacterum ananas Serrano, tbid. (not to be confused with Evunia ananas Serrano, tbid., \$5, 1928, 271); Bacterum serrano Burgaitz, Bact. Dis. of Plants, Leningrad, 1938.) From Brazilian Indian, ananas, pineapple; M. L. Ananas, generic mane.

Rods. 0 6 by 1 8 microns. Motile with 1 to 4 polar flagella. Gram-negative.

Green fluorescent pigment produced in certain media.

Gelatin: Liquefied.

Beef-extract glucose agar colonics: White, with undulating edges, smooth to rugose, glistening to dull.

Beef-extract agar. Growth scant.

Broth: Feeble growth.

plicatum (Bacterium), 761 plicatum (Flavobacterium), 441 plicatus (Bacillus), 149, 441, 665, 684, Plocamobaclerium, 18, 25, 27, 349, 381, 400 plumbeus (Bacillus), 665 plumosum (Corynebacterium), 405 plumosum (Mycobacterium), 405 plumosus (Micrococcus), 271 plurichromogenes (Aclinomyces), 897 pluricolor (Actinomyces), 973 pluricolor (Nocardia), 973 pluricolor (Streptolhrix), 973 pluricolor diffundens (Actinomyces), 973 pluricromogena (Streptolhrix), 897 plurisoptica (Pasteurella), 517 plurisepticus (Bacillus), 546 plulon (Bacıllus), 724 pluton (Diplococcus), 724 plymouthensis (Bacillus), 482 plumouthensis (Eruthrobacillus), 482 plymuthicum (Bacierium), 482 plymuthicum (Serratia), 481, 482, 483,

484, 485 Pneumobacillus, 45S Pneumococcus. 306 pneumo-enteritidis murium (Bacillus). 665

pneumoniae (Bacillus), 458, 652 pneumoniae (Bacterium), 307, 458 pneumoniae (Diplococcus), 43, 45, 306, 307, 308, 309

pneumoniae, Type 3 (Diplococcus), 30S pneumonsae (Encapsulalus), 458

1119

pneumoniae (Proteus), 458 pneumoniae (Streptococcus), 307 pneumoniae caprae (Bacillus), 553 pneumoniae crouposae (Mierococcus), 307 pneumoniae equi (Bacillus), 553 pneumonicum (Bacterium), 458, 675 pneumonicus (Bacillus), 647 pneumonicus agrlis (Bacillus), 647 pneumonicus agīlis (Bacterium), 647

pneumonicus liquefaciens (Bacıllus), 675 pneumonicus liquefaciens (Bacterium), 675

pneumonie crouposae (Baclerium), 458 pneumopecurium (Bacterium), 684 pneumosepticum (Bacterium), 684 pneumosepticus (Bacillus), 665, 684 pneumosepticus (Bacterium), 665 pneumosimilis (Streptococcus), 312 pneumosintes (Bacillus), 595 pneumosintes (Bacterium), 595 pneumosintes (Dialister), 595 Podangium, 1009, 1034 podovis (Treponema), 1074 poeciloides (Bacillus), 368, 369 poeciloides (Eubacterium), 368, 369 poelsii (Bacillus), 665 poinsettiae (Corynebacterium), 393, 399 poinsettiae (Phytomonas), 399 pollacii (Bacillus), 751 pollachii (Spirochaeta), 1069 pollachii (Spironema), 1069 Pollendera, 703 Polyangium, 5, 14, 17, 20, 24, 26, 1005, 1009, 1025 7 . . 1 .. .. 1008

POLY CALL VIEW polychromogenes (Oospora), 597 polychromogenes (Proactinomyces), 837 polychromogenes (Streptothriz), 897 polycolor (Bacterium), 126 polycolor (Phytomonas), 126 polycolor (Pseudomonas), 89, 126 polycyslus (Chondrococcus), 1015 polycystus (Myzococcus), 1045 polydorae (Cristispira), 1056 polydorae (Cristispirella), 1057 · \*. f--mentionm (Clostridium), 772, 824

polymorphum (Halibacterium), ...

minout (Actinomucen), 921 minovi (Nocardia), 921 nintae (Trenonema), 1872 ninientis (Wollachia), 1098 ninistrelli (Grahamella), 1111 ministrelli (Grahamia) 1111 miriforme (Cornnebacterium), 694 piscotoro (Shinella), 544 miscotorum (Bacterium), 483 niscatorum (Serratia). 483 piscalorus (Bacillus), 483 maces (Rielettsia), 1007 mismerdus (Barrllus), 751 misercidus aorlis (Bacillus), 751 niserridus ambs (Racterium), 751 niscicidus nobilis (Racillus), 751 piscicidus i ersicolar (Bacillus), 491 piscicidus teraicolor (Profeus), 491 piscrum (My cobacterium), 833, 884, 885. 886, 887 piscium (Vibrio), 197 piscova (Pseudomanas), 700 piet (Berillie), 751 pist (Baclerium), 119 pist (Marmor), 1180 pist (Phytomonas), 119 pist (Pseudomonas), 119 pistiense (Thiospicillum), 853 pithees (Spirillum), 1064 pithecs (Spirochaeta), 1064 pitheci (Spironema), 1064 piluitans (Bacterium), 761 pituitoparus (Hierococcus), 271 piluitoparus (Karphococcus) (Carphococcus), 271 pituitosum (Bacterium), 425, 684 pituitosum (Propionibacterium), 379 pityocampae (Bacierium), 654 pitycampae a (Streptocoecus), 342 pitycompae & (Streptococcus), 342 placoides (Cladothrix), 974 placoides (Leptotrichia), 974 placoides alba (Leptothrix), 974 plagarum (Inflabiliz), 823 placarum-belli (Diplococcus), 310

Planococcus, 7, 13, 15, 235

Planomerista, 235 Planetarring, 7, 15, 285 Planostrepiococcus, 15, 312 plantagines (Phytomonas), 161 plantaginis (Xanthomonas), 161 plantarum (Lactobacillus), 256, 357, 363 895 plantarum (Streptobactersum). 356 plantarum var rudensis (Lactobacillus). platus (Racillus), 723 platuchama (Bacillus), 751 plants (Fusocillus). 581 planti-vencents (Fusobacterium), 581. planti-sincents (Fusiformis), 581 plant-vincents (Spirochaete), 1063 plebra (Escherichia), 451 nleberus (Bacellus), 451 Pleetridium, 7, 13, 33, 763 Plectrillium, 7 Plectrinum. 7 plehnege (Pseudomonas), 149 Plennobacterium, 705 pleofeucts (Bacsilus), 346 pleofructs (Leucanastoc), 346 pleomorpha (Pseudomonas), 700 pleamarphus (Bacillus), 665 pleomorphus (Streptococcus), 342 pleuriticus (Discomyces), 915 pleuriticus (Leplathrix), 915 pleuriticus canis familiaris (Aclinomyces), 915 Pleuroppeumonia, 1289 pleuropneumoniae (Bacterium), 684 pleuropneumoniae (Bottmuces), 1291 plexiformis (Bacillus), 751 plicata (Pseudomonas), 149 plicatile (Spirillum), 1052 plicatilis (Ehrenbergia), 1052 plicatilis (Spirochaeta), 1052, 1053 plicatiles (Speridena), 1052 plicateles eurystrepta (Spirochaeta), 1052 plicalilis marina (Spirochaeta), 1052 plicatilis plicatilis (Spirochaeta), 1052 Plicaticum (Bacterium), 684, 761 plicatum (Acetobacter), 186

prodigiosa (Salmonella), 480 prodigiosum (Bacteridium), 480 prodigiosum (Bacterium), 480 prodigiosum (Chromobacterium), 480 prodigiosum (Dicrobactrum), 480 prodigiosum (Liquidobacterium), 480 prodigiosus (Bacillus), 480 prodigiosus (Erythrobacillus), 480 prodigiosus (Micrococcus), 480 productus (Streptococcus), 343 profundus (Cladothrix), 983 profusum (Bacterium), 684 profusus (Bacillus), 684 progrediens (Micrococcus), 272 progrediens (Reglillus), 823 prolifer (Vibrio), 213 promissus (Bacillus), 666 propera (Thiospira), 702 Propionibacterium, 30, 31, 372 propionici (Micromonospora), 980 Propionicoccus, 11

781, 825

Protaminobacter, 32, 189
protea (Actinomyces), 972
protea (Microspira), 197
protea (Pseudomonas), 140
protea-funcioseans (Pseudomonas), 89
proteamaculans (Bacterium), 169
proteamaculans (Pseudomonas), 169
proteamaculans (Pseudomonas), 169
proteamaculans (Satuthomonas), 169
proteids (Bacillus), 606
proteiformis (Enterococcus), 325
proteiformis (Streptococcus), 325
proteiformis liquefaciens (Enterococcus), 343

protesforms var liquefaciens (Streptococcus), 343 proteolyticum (Clostridium), 821 proteolyticum (Plocamobacterium), 691 proteolyticus (Silycobacter), 691 proteolyticus (Martellillus), 823 proteosimilis (Eberthella), 534 proterus (Bacillus), 666 proteum (Bacterium), 718

Proteus, 18, 21, 26, 31, 486, 489, 490, 491. 689, 691, 1086, 1088, 1089, 1091, 1092, 1093, 1103 proteus (Bacillus), 486 proteus (Bacterium), 691 proteus (Flavobacterium), 438 proteus (Oospora), 973 proteus (Streptococcus), 343 proteus (Streptothrix), 973 proteus (Vibrio), 197, 202, 204, 205 proteus anindolgenes (Bacterium), 487 proteus fluorescens (Bacillus), 89 proteus fluorescens (Bacterium), 698 proteus mirabilis (Bacillus), 488 proteus septicus (Bacillus), 686 proteus vulgaris (Bacillus), 487, 632 proteus-zenkeri (Bacıllus), 608 Protobios, 1128, 1129 protobios (Protobios), 1128 protozoides (Bacterium), 145 prowazeki sub-species typhi (Rickettsia), prowazeki var. mooseri (Rickettsia), 1088 prowazekí var. prouazeki (Rickettsia), prowazek11 (Rickettsia), 1084, 1086, 1087, 1088, 1000, 1004, 1096, 1097, 1103 pruchi: (Bacıllus), 788 pruchii (Clostridium), 788 pruddens (Bacillus), 666 pruneaeum (Flavobacterium), 441 pruni (Bactersum), 152 pruni (Nanus), 1203 pruni (Phagus), 1135

pruni (Xanthomonas), 152, 1129, 1134, 1135
pruntola (Pseudomonas), 120, 123
pruvot: (Coleomitus), 1003
prutoti (Coleomitus), 1003
prutoti (Coleomitus), 1003
prutoti (Coleomitus), 1003
prutoti (Coleomitus), 772
pseudoacti (Bacterium), 761
pseudoactinomycosis polymorphus (Coc-

pruni (Phylomonas), 152 pruni (Pseudomonas), 152

cobacillus), 974
pseudoagalactiae (Streptococcus), 319

nolumorphum (Rhizahium), 224 nolymorphum convulsivum (Bacterium). nolumorphus (Actinobacter), 456 nolumornhus (Bacillus), 684 nolumornhus (Funiormis), 582 polymorphus (Streptococcus), 343 polymorphus (Vabrao), 205 polymorphus necroticans (Coccobneillus). nolumorahus mecroticons (Micrococcahacillus), 690 polymorphus var perstriche (Vibrio), 205 polymyza (Aerobacilius), 720 polymyza (Bacillus), 720, 722, 754, 818 polymuza (Clostridium), 720 nolunnica (Granulabacter), 720 polymyza var mucosum (Granulobacter). 720 polymuza var. tenaz (Granulobacter), 720 naluniformie (Cornilia), 816 polypiformis (Bacillus), 816, 818 polypus (Micrococcus), 272 polysclerotica (Spirochaeta), 1065 polysiphoniae (Bacterium), 624 volusiphoniae (Flavobacterium), 624 polympura (Spirochaeta), 1074 poluspirum (Treponema), 1074 polyapora (Crenothrix), 983, 987 polyspora (Metabacterium), 762 polytrophum (Netrobacter), 76 nomodoriferus (Bacillus), 665 vomona (Salmonella), 529 ponces (Bacillus), 565 ponceti (Actinomyces), 921 poncets (Nocardia), 921 poncett (Oospora), 921 ponticus (Vibrio), 703 Pontothrix, 1002 poolensus (Actinomuces), 949 poolensis (Streptomyces), 949 poona (Salmonella), 527, 531 populitae (Bacillus), 727 populs (Bacillus), 751 populs (Micrococcus), 272 porcellorum (Micrococcus), 272

porce (Erysepelothrex), 410

more (Racillus) 684 porrs (Bacterium), 684 partes (Spirillum), 1052 portuensis (Microspira), 205 partnerses (Vibrio), 205 postumus (Bacillus), 816 potens (Acetobacter), 692 notedam (Salmonella), 511 notedomensis (Salmanella), 511 processula (Zuberella), 577 praencutus (Coccobacillus), 577 process (Actinomuces), 923 praefemindus (Actinomyces), 973 praepallens (Bacellus), 665 prousanitzes (Bacellus), 718 provisantais (Bacterondes), 577 preizz-nocardi (Corunebacterium). 339 premens (Tarpeia), 1270 preputialis (Leptothrix), 366 pretoria (Salmonella), 526 pretoriana (Nocardia), 900 pretorsanus (Actinomuces), 900 prillieuxianus (Bacillus), 132 prima (Vibrio), 205 primarius (Phagus), 1132 primigenium (Archangium), 1018, 1019 primigenium (Polyangium), 1018 var. primernum ASSULTED BY (Arch. angium), 1006, 1018 primulae (Marmor), 1201 primulae (Phytomonas), 314 primulae (Pseudomonas), 114 primus (Robertsonellus), 823 primus fullest (Bacillus), 666 primus fulless (Bacterrum), 666 pringaheim (Bacillus), 819 priztnitzi (Bacellus), 534 prizinita (Bacterium), 534 prizinitzi (Eberthella), 534 prizinitze (Eberthus), 534 Proactinomyces, 33, 875, 892

Proactinomyces sp., Helzer, 923

probatus (Bacillus), 729

prodenine (Buclerium), 684

prodigiosa (Micraloa), 480

prodiciosa (Palmella), 480

prodigiosa (Monas), 480

pscudonavicula (Bacillus), 814, 816 pseudoneerophorus (Actinomnees), 580 pseudocedematis (Bacillus), 816 pseudovedcmatis maligni (Bacillus), 660. 816 neendonalled . 10.

pscudo-perfringens (Inflabilis), 823 pseudopestis murium (Bacterium), 402 pseudopneumonicum (Bacterium), 685 pseudopneumonieum (Brucella), 685 pseudopneumonicus (Bacillus), 685 pseudoproteus (Aerobacter), 457 pseudopyogenes (Corynebacterium), 388 pseudoradiatus (Bacillus), 613 pseudoramosum (Ramibacterium), 369 pseudoramosus (Bacillus), 309, 488 pseudoramosus (Bacteriodes), 369 pseudorecurrentis (Spirochaeta), 1069 pseudoruber (Bacillus), 752 Pseudosarcina, 285 pscudosarcina (Micrococcus), 219 pseudo-septicus (Bacillus), 816 pscudosolidus (Barillus), 816 Pseudospira, 192 pseudospirochaeta (Vibrio), 205 pseudospirochocta A (Vibrio), 205 pseudospirochaeta B (Vibrio), 205 pseudospirochaeta C (Vibrio), 205 Pseudostreptus, 12, 13, 14, 312 pseudosubtilis (Bacillus), 752 pseudotetani (Bacillus), 727, 728, 800, 816 pseudoletanicum (Plectridium), 801 nscudotetanicus (Bacillus), 727, 728, 816, pseudotetanicus aerobius (Bacillus), 727 pseudo-telanus, Type No IX (Bacillus),

pseudotsugae (Bacterium), 230 pseudotsugae (Phytomonas), 230 pseudotuberculosa (Streptothrix), 973 pseudotuberculosis (Bacillus), 389, 550, 666

pseudotuberculosis (Bacterium), 550

pseudotuberculosis (Corynebacterium), 389, 550 pseudotuberculosis (Mycobacterium), 390 pseudotuberculosis (Nocardia), 973 nseudotuberculosis (Pasteurella), 549, 550, 677, 703 pseudoluberculosis bovis (Corynebacterium), 389

pseudotuberculosis liquefaciens (Bacillus), 666 pseudotuberculosis murium (Bacillus),

389, 407 pseudotuberculosis murium (Corynethrix),

pseudotuberculosis ovis (Bacillus), 389 nscudotuberculosis ovis (Corynebacterium), 383 pseudotuberculosis rodentium (Bacillus),

pseudotuberculosis rodentium (Bacterium), 550

pseudotuberculosis rodentium (Corunebacterium), 550 pseudotuberculosis rodentium (Malleo-

myces), 550 nseudotuberculosis rodentium (Streptobacillus), 550

pseudotuberculosis similis (Bacillus), 652 pseudotuberculosus (Actinomyces), 973 pseudotyphi (Rickettsia), 1000 pseudotyphosa (Pseudomonas), 149 pseudotyphosum (Bacterium), 613, 666 pseudolyphosus (Bacillus), 612, 666 pseudovacuolata (Leptothrix), 986 pseudoracuolata (Spirothrix), 986 nseudovaleriei (Proteus), 491

pseudovermiculosum (Bacterium), 761 pseudoviolacea (Pseudomonas), 234 pseudozerosis (Bacillus), 1098 pseudozoogloeae (Bacterium), 124 pseudozoogloeae (Phytomonas), 121 pseudozoogloeae (Pseudomonas), 124, 130

paittaci (Ehrlichia), 1116 pattaci (Miyagawanella), 1116, 1117, 1118, 1119

prittaci (Richettsia), 1116

pseudanthracis (Bacillus), 716, 717, 751 pseudoanthracis (Bacterium), 717 pseudo-asiatica (Salmonella), 532 pseudo-asiatica var mobilis (Salmonella),

532
pseudo-asiaticus (Bacillus), 532
pseudo-asiaticus mobilis (Bacillus), 532
Pseudobacillus, 0, 22
pseudobacillus, 0, 22
pseudobacillus (Bacillus), 1009
pseudobatyricus (Bacillus), 740, 820
pseudocarreus (Asleroides), 918
pseudocarreus (Asleroides), 918
pseudocarolinus (Bacillus), 532
pseudocarolinus (Bacillus), 532
pseudocarolinus (Bacillus), 103
pseudocebachalis (Neisseraci, 301
pseudocebi (Harmobartonella), 1103
pseudocebi (Harmobartonella), 1103
pseudocebi (Harmobartonella), 129
pseudo-cholerus (Micrococcus), 249
pseudo-cholerus (Micrococcus), 249
pseudo-cholerus (gallinarum (Bacillus), 820

pseudoclostridium (Bocterium), 818 pseudococcus (Bacillus), 751 Pseudocoli (Raeillus) 453 pseudocoli (Escheriebia), 453 pseudo-cols anarobse (Bacellus), 786 pseudocols angerobius (Bacillus), 786 preudocoliformis (Bacillus), 453 preudo-coliformis (Escherichia), 453 pseudocoloides (Bacillus), 453 pseudo-coloides (Bacterium), 453 pseudocoloides (Escherichia), 453 pseudo columbensis (Bacillus), 532 pseudo columbensis (Salmonella (1)), 532 pseudoconjunctivitidis (Bacillus), 634 pseudoconjunctivitidis (Bacterium), 684 pseudocoscoroba (Escherichia), 453 pseudocyaneus (Micrococcus), 272 pseudodiphtheria (Bacillus), 390 pseudodiphtheriae (Corunebactersum). 404, 405

pseudodiphthericum (Mycobacterium), 385 pseudodiphthericum magnus (Bacillus), 752 Pseudodiphthericus (Bacillus) 985

pseudodrphthericus (Bacillus), 385 pteudodrphtheriticum (Bacterium), 385 pseudodrphtheriticum (Corynehacterium), 385, 406

pscudodiphtherstieus acidum faciene (Bacillus), 401 pscudodiphtheriticus alcalifaciens (Bacillus), 400 pseudodiphthersticus gazogenes (Bacillus), 401 Pseudodiphthersticus 305

pseudodysenteriae (Bacillus), 538
pseudodstyenteriae (Bacillus), 533
pseudodysenteriae (Becherichia), 453, 543
pseudofysichicinum (Bacterium), 453, 543
pseudofilicinum (Bacterium), 654
pseudofilicinum (Bacterium), 652
pseudoshaemolyticus (Streptoooccus), 343
pseudoshaemolyticus (Streptoooccus), 343
pseudostendamis (Spirochaeta), 1077
pseudosterogenes (Epropheria), 1077
pseudosterogenes (Spirochaeta), 1077
pseudosterogenes (Spirochaeta), 1077
pseudosterogenes aquaeductuum (Spiro-chaeta), 1077

chaets), 1078
pseudo-icterogenes (aguatilis) (Spirochaets), 1077

pseudoicterogenes salina (Spirochaela), 1979 pseudo-scierohemorrhagiae (Spirochaela).

1077
preudoinfuenzae (Bacillus), 684
preudoinfuenzae (Bacieruum), 681
preudoinfuenzae (Micrococcus), 272
preudoinfuenzae (Micrococcus), 272
preudoiralomalacaue (Bacieruum), 684
Preudoile Plothiriz, 34, 366
preudomallie (Bacillus), 816
preudomallie (Bacillus), 555
preudomallie (Bacillus), 555
preudomallie (Flawbacterium), 555
preudomallie (Flawbacterium), 555
preudomallie (Flawbacterium), 555
preudomallie (Flawforellus), 555, 556
preudomallie (Malleomyces), 555, 556
preudomallie (Pletforellus), 556
preudomallie (Pletforellus), 563
preudomarabitis (Bacillus), 666
Preudomona, 7, 15, 16, 20, 21, 25, 25, 20,

633, 692, 839
pseudo-morgans (Bacillus), 532
pseudo-morgans (Salmonella), 532
pseudomudispediculum (Bacterium), 685
pseudomycoides (Bactersum), 761
pseudomycoides roseus (Bacillus), 761

31, 32, 43, 82, 91, 145, 171, 233, 234, 615,

putrefaciens (Achromobacter), 99 putrefaciens (Acuformis), 802 pulrefaciens (Bacillus), 802 putrefaciens (Clostridium), 802 putrefaciens (Palmula), 802 putrefaciens (Pseudomonas), 99 putrefaciens (Streptococcus), 343 putrefaciens putridus (Bacillus), 477 Putribacillus, 8, 763 Putriclostridium, 11, 763 putrida (Pseudomonas), 96 putridogenes (Actinomyces), 921 putridogenes (Cladothrix), 921 putridogenes (Nocardia), 921 putridogenes (Oospira), 921 putridus (Micrococcus), 272 putridus (Streptococcus), 329 putridus (Vibrio), 205 putrifica (Pacinia), 799 putrificum (Plectridium), 799 putrificum var, lentoputrescens (Plectridium).799 Putrificus, 11, 20, 22, 763 putrificus (Bacillus), 799, 800 putrificus (Clostridium), 799 putrificus (Staphylococcus), 232 putrificus (Streptococcus), 329 putrificus coagulans (Bacillus), 816 putrificus coli (Bacillus), 727, 737, 799, putrificus filamentosus (Bacıllus), 800 putrificus immobilis (Bacillus), 813, 817 putrificus oralaris (Bacillus), 796 putrificus tenuis (Bacillus), 787, 826 pulrificus var. non liquefaciens (Bacillus), 816 putrificus verrucosus (Bacillus), 782, 825 pyaemiae cunsculorum (Micrococcus), 271 pyaemicum (Baclerium), 685 pycnotica (Hydrogenomonas), 752 pycnoticus (Bacillus), 752 pyelonephritis boum (Bacillus), 388 pygmaeum (Clostridium), 821 pygmaeus (Micrococcus), 272 pylor: (Bacillus), 416, 666 pyocinnabarcum (Bacterium), 685

pyocinnabareus (Bacillus), 685

Pyococcus, 235 pyocyanea (Pseudomonas), 7, 89 pyocyaneum (Baclerium), 89 pyocyaneus (Bacillus), 89, 146 pyocyaneus (Micrococcus), 89, 272 pyocyaneus saccharum (Bacillus), 121 pyogenes (Actinomyces), 934, 973 pyogenes (Albococcus), 242 pyogenes (Bacillus), 388, 666 pyogenes (Bacterium), 338, 534, 685 pyogenes (Bacteroides), 579 pyogenes (Castellanus), 534 pyogenes (Corynebacterium), 388, 391, 401, 404, 405, 694 pyogenes (Diplococcus), 343 pyogenes (Eberthella), 534 pyogenes (Lankoides), 534 pyogenes (Micrococcus), 241, 242, 343 18, ... pyogenes (Treponema), 217 pyogenes (Vibrio), 206 pyogenes var. albus (Micrococcus), 212, pyogenes var. aureus (Microcaccus), 241, 271, 284 pyogenes var. liquefaciens (Bacillus), 666 pyogenes var. scarlatinae (Streptococcus), 315 pyogenes albus (Staphylococcus), 242 albus (Tetracoccus (Micropyopenes coccus)), 242 pyogenes anaerobius (Bacillus), 579, 685 pyogenes anaerobius (Bacterium), 685 pyogenes animalis (Streptococcus), 316 pyogenes aureus (Slaphylococcus), 241 pyogenes aureus (Tetracoccus) (Micrococcus), 241 pyopenes boris (Bacillus), 338, 405, 666 pyogenes bovis (Corynebacterium), 388, pyogenes boris (Eubacterrum), 405

nsittaeorum (Streplacaceus), 312 psittacasie (Racillus), 502 nsittacasis (Racterium), 502 usittacosis (Salmanella), 502 proposes (Cativir), 1209 penrocia (Rimocartine) 1210 psorosis var alveatum (Rimocortius). 1211 process var anulatum (Rungcortius) psorosis var conjucum (Rimocortius). 1210 usuchrocarteries (Urosarcina) 289 psychrocorterica (Saccina), 289 psychrocarterieus (Raeillus), 729 psychrocarterieus (Urobacillus), 729 nueroriae (Racierum), 118 puerariae (Phytomonas), 118 pueris (Salmonella), 513 puerperalis (Streptpeocens), 315 pulcher (Micrococcus), 272 pulchra (Sarcina), 293 pullorum (Bacillus), 521 pullorum (Bacterium), 521 pullorum (Borrelia), 1059 pullorum (Salmonella), 43, 493, 498, 520, 521, 1135 pullulans (Bacillus), 149 pullulans (Bacterium), 700 pullulans (Pseudomonos), 149, 700 pulmonalis (Actinomyces), 901, 923 pulmonalis (Discomuces), 922 pulmonalis (Nocardia), 901, 923 pulmonelis (Oospora), 917, 922 pulmonalis vas. chromogena (Oospora). pulmonalis var. chromogenus (Actinomyces), 923 pulmonare (Monas), 307 pulmonia (Murimyces), 1292 pulmonis I and II (Canomyces), 1202 pulmonis equi (Zoagloea), 252 pulmonum (Bacillus), 612 pulmonum (Sarcina), 291, 293 pulpac pyogenes (Bacillus), 666 pulliformis (Micrococcus), 272 pulriforme (Mycobacterium), 882

pumilus (Bacıllus), 709, 712, 744

610

nunelatum (Achromobacter), 102 nunctatum (Bacterium), 102, 324 nunctatum (Netcohacter), 76 punctatus (Racillus), 102, 666 nunciatus (Micrococcus), 272 nuncticulatus (Racillus), 666 puncisforms (Bacillus), 752 nunrtidans (Racteerum) 113 punctum (Bacillus), 685 nunctum (Bactersum), 685 nunctum (Monas), 685 puntonis (Actinomuces), 917 munious (Asterondes), 917 Punella. 5 nurriaciens (Bacterium), 557 purifaciens (Pasteurella), 557 nures (Pseudomonas), 700 purpeochromogenus (Actinomyces), 943 purpeochromogenus (Streptomyces), 943 purpureus (Actinomyces), 917, 973 purpursfaciens (Micrococcus), 272 purnurum (Bacterium), 552 purulentus (Corvnebacterium), 391 puedla (Cellulomonos), 621 pusilla (Cristispara), 1057 punilla (Spirochaeta), 1057 pusitus (Barillus), 621 pusiolum (Bactersum), 145 pustulatus (Micrococcus), 272 putatus (Micrococcus), 696 putids (Pseudomonas), 96 putida (Ristella), 575

putneus (Micrococcus), 696 putorsi (Actinomyces), 973 putorsi (Streptothriz), 973 putororum (Hemophilus), 589 putredinis (Bacillus), 575, 640 putredinis (Bacterum), 640 putredinis (Ristella), 575

radians (Bacillus), 667, 710 radiata (Cornilia), 799 radiata (Nocardia), 973 radiata (Sarcina), 293 radiatum (Bacterium), 635, 761 radiatum (Flavobacterium), 441 radiatus (Actinomyces), 973 radiatus (Bacillus), 441, 613, 662, 799, radiatus (Micrococcus), 273 radiatus (Streptococcus), 273, 343 radiatus (Streptothrix), 973 radiatus anaerobius (Bacillus), 799 radiatus aquatilis (Bacıllus), 441, 613 radiatus aquatilis (Bacterium), 613 radicicola (Bacillus), 43, 224, 225 radicicola (Bacterium), 221, 225 radicicola (Pseudomonas), 225 radicicola (Rhizomonas), 225 radicicola var. liquefaciens (Bacillus), radiescolum (Rhizobium), 225 radiciperda (Bacterium), 141 radiciperda (Phytomonas), 141 radiciperda (Pseudomonas), 141 radicosum (Bactersum), 718 radicosus (Bacıllus), 718 radiiformis (Bacillus), 566 radiobacter (Achromobacter), 229 radiobacter (Agrobacterium), 229, 230 radiobacter (Alcaligenes), 229 radiobacter (Bacillus), 229 radiobacter (Bacterium), 229 radiobacter (Rhizobium), 229 radiosus (Micrococcus), 273 raffinolactis (Streptococcus), 325 raffinosaceum (Propionibacterium), 377 raillieti (Spirochaeta), 1069 Ramibacterium, 33, 34, 368 ramificans (Bacillus), 667 ramificans (Bacterium), 685 ramigera (Zoogloea), 150 ramosa (Cladothrix), 983 ramosa (Nevskia), 830 ramosa (Nocardia), 368 ramosa (Pasteuria), 836 ramosoides (Bacillus), 369

ramosoides (Ramibacterium), 369 ramosum (Pseudorhizobium), 225 ramosum (Ramibacterium), 368 ramosus (Actinomyces), 368 ramosus (Bacillus), 363, 718, 801, 827 ramosus (Fusiformis), 369 ramosus liquefaciens (Bacıllus), 715 ranae (Mycobacterium), 883, 884, 885, 886, 887 ranarum (Bartonella), 1108 ranarum (Haemobartonella), 1108 ranarum (Spirochaeta), 1069 rancens (Acetobacter), 180, 182, 184, 692 rancens (Bacillus), 182 rancens (Bacterium), 182 rancens (Ulvina), 602 rangiferinum (Bacterium), 685 rangiferinum (Plocamobacterium), 685 rangoon (Actinomices), 911 rangooneusis (Nocardia), 911 ranicida (Bacıllus), 102 ranicida (Bacterium), 102 ranicida (Salmonella), 532 ranicola I and II (Mycobacterium), 890 ranicula (1 ibrio), 206 raphani (Marmor), 1200 rappini (Spirillum), 217 rarerepertus (Bacillus), 753 rarus (Bacillus), 752 rasmussent (Bacillus), 367 rasmusseni (Bacteriopsis), 367 Rasmussenia, 365 rathay (Bacterium), 394 rathays (Aplanobacter), 394 rathayi (Corynebacterium), 394, 400 rathay: (Phytomonas), 394 rathonis (Achromobacter), 104 rathonis (Pseudomonas), 104 ratti (Streptothrix), 588, 972 raceneli (Bacillus), 426 ravenelii (Achromobacter), 426 reading (Salmonella), 501 readingensis (Salmonella), 493, 504 reading var. Laapstad (Salmonella), 505 rebellis (Neisseria), 301 Recordillus, 11, 763 recta (Spirochaeta), 1069

vogenes bovis (Stanhulococcus). 264. 281.

pyogenes boys (Strentococcus), 343 pyogenes cutreus (Micrococcus). 242 pyogenes citreus (Staphylococcus). 242 nuocenes crassus (Bacillus), 652 nyogenes crassus (Bacterium), 652 nvoqenes cuntculi (Bacellus). 403 pyogenes cuniculi (Leptothrix). 366 pyogenes duodenalis (Streptococcus), 783 pyogenes (equi) Corynebacterium, 391 (pyogenes) equi roseum (Corynebacterium). 391

pyogenes equi (Streptococcus), 317 pyogenes filiformis (Bacillus (Leptothriz?)), 366

pyogenes floccosus (Streptobacullus), 579 pyogenes foetidus (Bacillus), 534, 817 pyogenes foetidus (Bacterium), 534 pyogenes foetidus liquefaciens (Bacillus),

pyogenes foetidus liquefaciens (Bactersum), 656, 666 pyogenes gingivae (Bacillus), 657

pyogenes haemolyticus (Streptococcus), 315 pyogenes hominis (Sireplococcus), 343 pyogenes lentus (Strepiococcus), 311 pyogenes liquefactens albus (Staphylococcus), 282

pyogenes malignus (Streptococcus), 341 pyogenes minutissimum (Bocterium), 607 pyogenes minutissimus (Bacillus), 607 pyogenes nonhaemolyticus (Streptococcus). 343

pyogenes salivarius (Staphylococcus), 258 pyogenes sanguinarium (Bacterium), 520 pyogenes soli (Bacillus), 666 pyogenes suis (Bacillus). 388 pyogenes auts (Bacterium), 388

pyogenes tenuis (Micrococcus), 306, 307 Pyogenes tenurs (Staphylococcus), 282 pyogenes ureae (Streptococcus), 344 pyogenes rulyaris (Streptococcus), 345 pyorrhoeica (Spirochoeta), 1069

pyoseptica (Serratia), 484 pyosepticum (Bacterium), 541

pyosepticum equi (Bacterium), 541

pyosepticus (Bacillus), 541 puosenticus (Eruthrobacillus). 10. 484 puosepticus (Micrococcus), 272 puesepticus (Staphylococcus), 272 pyramers I and II (Bacillus), 666 pyraustae Nos. 1-7 (Bacterium), 685 nurenei (Bacillus), 761 purenes No. 1. No. 2 and No 8 (Bacterum), 761 purs (Bactersum), 640 Dyrs (Marmor), 1211 DVrs (Rimocortius), 1211 pyriformis (Myzococcus), 1041 pyrogenes (Leptospira), 1079

quadrigeminus (Micrococcus), 273 quadrigeminus (Stophylococcus), 273 qualis (Bacterium), 603 quarta (Fractilinea), 1161 quartum (Eubacterium), 367 quartum (Marmor), 1101 quaternus (Micrococcus), 273 queenslandiensis (Galla), 1158 quercifolium (Bacterium), 752 quereifolius (Bacillus), 752 querquedulae (Treponema), 1076 quintana (Possilis), 1091 quintana (Rickettsia), 1094, 1095 quintum (Eubacterium), 367

pyrogenes (Spirochaeta), 1070 pyrphoron (Heliconema), 1064

raabi (Terminosparus), 823 rabida (Pacinia), 696 rabie: (Encephalitozoon), 1264 Rabula, 1284 ----

---- (Macterium), 603 racemosum (Flavobaclerium), 603 Milk · Becomes alkaline with curd. Nitrites not produced from nitrates. Indole not formed.

No II<sub>2</sub>S formed

Acid but not gas from glucose, xylose and mannitol. Feeble with lactose. No acid with sucrose.

Starch not hydrolyzed.

Optimum temperature 30° to 31°C. Maximum 45°C. Minimum 7° to 10°C. Aerobic.

Habitat: Causes a rot of pincapples, Ananas comosus.

101. Pseudomonas Ilgustri (d'Oliveira) comb nov. (Bacterium ligustri d'Olireira, Revista Agron., 24, 1936, 434.) From L. ligustrum, privet; M. L. Ligusrum, a generie name.

Rods 0 5 to 0.7 by 1 3 to 3 microns. No chains. No capsules. Motile with 1 to 5 polar flagella. Gram-negative. Green pigment produced on Doy agar.

Green pigment produced on Dox agar, and in broth.

Gelatin. Liquefied

Beef-extract agar colonies:

Broth. Turbid in 24 hours. No pelicle.

Milk Coagulated in 6 days, and later digested. Litmus slightly acid.

Nitrites not produced from nitrates Indole not produced.

Ammonia not produced.

No gas from carbohydrates Acid froro glucose, galactose, arabinose and mannose. No acid from sucrose, maltose, actose, raffinose, manntol and salicin Source: From diseased Japanese privet

n Lisbon, Portugal. Habitat: Pathogenie on privet, Ligus-

trum japonicum.

102. Pseudomonas sesami Malkoff. (Malkoff, Cent f Bakt, II Abt., 16, 1036, 605; Bacterium sesami Nakata, Ann. Phyt. Soc. Japan, 2, 1930, 222 Phytomonas sesami Kovachersky, Ann. Univ. de Sofia, Fac. Agron, 8, 1930, 464.) From Gr. sesamum, sesame; M. L. Sesamum, a generic name.

Synonym: Nakata (loc. cit.) lists Bacterium sesumicola Takimoto, Jour. Plant Protect. Tokyo, 8, 1927, 433 (Phytomonas sesumicola Magrou, in Hauduroy et al., Diet. d. Bact. Path, 1937, 412).

Description from Nakata (loc. cit.).
Rods: 0.6 to 0 8 by 1.2 to 3.8 microns.

Motile with 2 to 5 polar flagella. Gramnegative.

Green fluorescent pigment produced in culture.

Gelatin: Liquefaction rapid.

Beef-agar colonies: Circular, flat, striate, smooth, entire margins, white,

Broth: Growth rapid. No pellicle. Milk: Alkaline. No coagulation. Nitrites not produced from nitrates. Indole not produced.

No II:S produced.

Acid but not gas from glucose. No acid from lactose, sucrose or glycerol. Starch not bydrolyzed.

Optimum temperature 30°C. Maxi-

mum 35°C. Minimum 0°C.

Facultative anaerobe.

Source: Isolated from brown spots on leaves and stems of sesame.

Habitat: Pathogenie on scsame

103. Pseudomonas tolaasil Painc. (Paine, Ann. Appl. Biol., 6, 1919, 210; Phytomonas tolaasi Bergey et al., Man ual, 3rd ed., 1630, 259; Bacterium tolaasi Elliott, Bacterial Plant Pathogens, 1930, 226.) Named for A. G. Tolaas who first reported the species.

Rods: 0.4 to 0.5 by 0.9 to 1.7 microns. Motile with 1 to 5 polar flagella. Gram-

negative.

Green fluorescent pigment produced in culture.

Gelatin: Liquefaction.

Bouillon agar: Streak develops in 24 bours, dirty bluish-white, wet-shining and slightly raised.

Broth: Turbid in 24 hours. Pellicle-Milk: Becomes alkaline and clears Nitrites not produced from nitrates. Indole production slight.

Acid but not gas from glucosc. No acid from lactose or sucrose.

rectale (Eubacterium), 367
rectalis (Bacteroides), 367
rectalis (Bacteroides), 367
recti (Alcaligenes), 415
recti (Alcaligenes), 415
recti (Bacterium), 415
recti physetrics (Spirillum), 217
rectiones (Proteus), 491
rectum (Treponema), 1000
rectum (Treponema), 1000
rectum (Hiderillus), 822
rectus (Hidlerillus), 822
rectus (Hidlerillus), 627
recuperatus (Bactlus), 667
recuperatus (Bactlus), 1255
recurrents (Seclus), 1225
recurrents (Seclus), 1225

1062, 1065, 1067, 1069
recurrentis (Gacospira), 1059
recurrentis (Protomycetum), 1059
recurrentis (Spirillum), 1059

reessi (Micrococcus), 273 refractans (Achromobacter), 426 refractans (Bacillus), 426 refractans (Bactersum), 426 refringens (Borrelia), 1063 refringens (Spirochaeta), 1063 refringens (Spironema), 1063 refringens (Spiroschaudinma), 1063 refringens (Treponema), 1063 regaudi (Spirella), 1009 regaudi (Spirochaeta), 1069 Reglillus, 11, 763 regulare (Clostridium), 785 regularis (Micrococcus), 273 regularıs filiformis (Bacıllus), 792 restenbaches (Lampropedia), 814 restenbachii (Merismopedium), 844 reitenbachis (Pediococcus), 844 restenbachit (Sarcina), 811 renale (Bacillus), 405 renale (Bactersum), 388, 405 renale (Corynebacterium), 388, 389 renale (cuniculs) (Bacillus), 404, 405 renale (enniculi) (Racternum), 405 renale cuniculi (Corunebacterrum). 388. 405 renalis (Bacillus), 388 renalis bovis (Bacillus), 388 renalis bovis (Corvnsbacterium), 388 reniforme (Bacterium), 817 rensformes (Bacillus), 817 reniformis (Divlocaccus), 300 rensforms (Micrococcus), 200 reniforms (Neisseria), 300 renss (Sarcina), 204 repacts (Spirochaete), 1070 repazu (Bacillus), 667 repens (Achorion), 921 renens (Actinomyces), 021 renens (Bacıllus), 752 repens (Bacterium), 685 repens (Epidermophyton), 921 repens (Lepocolla), 921 repens (Marmor), 1189, 1192 repens (Necardia), 921 reprimens (Borrelina), 1225 reprimens (Morsus), 1154 reptans (Bacillus), 752 rentans (Granulobacter), 822 reptilia (Treponema), 1076 renultvorous (Pseudomonas), 92 resinacea (Pseudomonas), 179 resinaceus (Micrococcus), 273 restatus (Thermobacillus), 732 restrictus (Proactinomuces), 923 retaneus (Bacillus), 752 reticulare (Achromobacter), 426 reticularia (Bacillus), 426 reticularia (Cladothrix), 983 reticularis (Sphaerotilus), 983 reticula (Actinomyces), 914 reticuli (Streptomyces), 944 reticulosa (Gallionella), 832 reticulus (Actinomyces), 915 reticulus-ruber (Actinomyces), 915 retiformans (Bacterium), 685 retiformis (Bacillus), 752 rettgeri (Bacıllus), 489 rettger: (Bacterium), 489 rettgeri (Butyrıbacterium), 380

640

roscopersicina (Lamprocystis), 848, 859 roseo-persicina (Planosarcina), 848 roseopersicina (Thiocapsa), 845 roseo-persicinus (Micrococcus), 273 rosco-persicinus (Pleurococcus), 848 roseo-persicinus (Protococcus), 848 rosettaceus (Micrococcus), 274 rosettae (Carpophthora), 1152 rosettae (Chlorogenus), 1152 rosettae (Nanus), 1152 roseum (Acetobacter), 183, 181 roseum (Amoebobacter), 849 roseum (Bacterium), 685 roseum (Clostridium), 805 roseum (Halibacterium), 667 roseum (Pelochromatium), 859 roseum (Rhabdochromatium), 854 roseum (Thioderma), 849, 858 roseus (Actinomyces), 937, 973 roseus (Bacillus), 667, 685, 709 roseus (Cryptococcus), 848 roseus (Diplococcus), 244 roseus (Discomyces), 973 roseus (Gluconoacetobacter), 694 roseus (Micrococcus), 244, 255, 258, 259, 262, 263, 265, 271, 273, 274, 276, 277, 279, 282 roseus (Pediococcus), 813 roseus (Planococcus), 843 roseus (Rhodococcus), 8, 244 roseus (Sphaerotilus), 983 roseus (Staphylococcus), 282 roseus fischeri (Bacillus), 667 roseus fluorescens (Bacillus), 645 roseus vini (Bacillus), 149 rossi (Borrelia), 1060 rossi (Spirochaela), 1060 rossi (Treponema), 1060 rossica (Cellulomonas), 618, 622 rossicus (Bacillus), 622 rossicus var castaneus (Bacıllus), 622 rossii (Endosporus), 803 rossii (Spiroschaudinnia), 1060 rostockensis (Salmonella), 493, 518 rotans (Bacillus), 728 rubea (Nocardia), 976 rubefaciens (Bacıllus), 640

rubefaciens (Serratia), 640 rubellum (Clostridium), 817 rubellus (Bacillus), 817 rubellus (Micrococcus), 274 rubens (Micrococcus), 244 rubentschickii (Desufovibrio), 208 rubentschickii (Vibrio), 208 rubeolae (Diplococcus), 310 ruber (Actinomyces), 917, 946 ruber (Bacillus), 481, 484, 752 ruber (Chromobacterium), 752 ruber (Discomyces), 917 ruber (Erythrobacillus), 481, 752 ruber (Micrococcus), 244, 850 ruber (Mycococcus), 891 ruber (Myxococcus), 1041 ruber (Proactinomyces), 905 ruber (Rhodococcus), 244 ruber (Streptococcus), 343 ruber (Streptomyces), 946 ruber (Thermobacillus), 734 ruber (Thiopolycoccus), 850 ruber aquatilis (Bacıllus), 667 ruber aquatilis (Bacterium), 667 ruber balticus (Bacillus), 482, 483 ruber balticus (Bacterium), 482, 483 ruber berolinensis (Bacillus), 650 ruber berolinensis (Baclerium), 650 ruber indicus (Bacillus), 481 ruber indicus (Baclerium), 481 ruber ovatus (Bacillus), 683 ruber sardinae (Bacillus), 483 ruber sardinis (Bacterium), 483 rubescens (Bucillus), 654, 667 rubercens (Bacterium), 667, 848 rubescens (Lankasteron), 848 rubescens (Micrococcus), 244, 277 rubescens (Myxococcus), 1041 rubescens (Streptomyces), 956 rubescens (Streptothrix), 956 rubi (Agrobacterium), 229 rubi (Bacterium), 229 rubi (Corium), 1205

rahi (Marmor), 1195 ruhi (Phutomonas), 229 rubi (Pseudomonas), 229 ruhi var beta (Corium) 1205 rubicola (Pseudomonas) 700 rubicundus (Vibrio) 206 rubida (Serratia), 641 rubidaca (Serratia), 484 rubidaeum (Bacterium), 484 rubidaureus (Actinomuces), 917 rubidum (Bacterium), 641 rubidus (Bacillus), 641 rubidus lactis (Micrococcus), 274 rubiformis (Bacillus), 667 rubinenosum (Bacterium), 685 rubicenosus (Bacillus), 535 rubigenosus (Micrococcus), 274 rubiginosum (Marmor), 1196 rubiginosus (Bacillus), 667 rubiginosus (Streptococcus), 274, 343 rubislaw (Salmonella), 526 suboris suis (Baeilfus), 410 ruborum (Corium), 1205 rubra (Cladothrix), 917 rubra (Cytophaga), 1013 rubra (Nocardia), 803, 905, 917 tubra (Oospara), 976 rubra (Sarcina), 293 rubra (Serratia), 752 rubra (Streviothriz), 904, 917 rubri var. alpha (Corsum), 1205 rubrica (Serratio), 644 rubricum (Chromobacterium), 614 rubricus (Bacillus), 644 rubricus (Erythrobacillus), 644 rubrilineans (Bacterium), 154 rubrilineans (Phytomonas), 154 tubrilineans (Pseudomonas), 154 rubrilineans (Xanthomonas), 154 rubriceticuli (Streptomyces), 945 rubrisubalbricans (Bacterium), 170 rubrisubalbicans (Phytomonas), 170 tubrisubalbicans (Xanthomonas), rubrofuscum (Halibacterium), 667 rubrofuscus (Bacillus), 667 rubropertineta (Nocardia), 904 rubropertincta (Serratia), 905

rubranertinetus (Mucabacterium), 904 rubronertinetus (Procetinamuces), 904 rubrum (Bacillus), 685 rubrum (Bactereum), 685, 686, 905 rubrum (Mucobacterium), 890, 905 rubrum (Plocamobacterium), 691 rubrum (Propionibacterium), 374, 375 277 rubrum (Proteminobacter), 190 rethrum (Rhodosnirillum), \$53, 867, 868 rubrum (Semiclostridium), 762 rubrum (Spirillum), 632, 867 rederion (Thioderma), 850 rubus (Bacillus), 667 endensis (Bacillus), 357, 359 rudensis (Lactobacillus), 259 rudis (Bacillus), 744 rnedineri (Bacillus) 406 ruedioera (Corunebacteraum), 405 rufa (Serratia), 644 rufa (Thiocystis), 847 rufescens (Bacillus), 739, 752 rufulus (Bacellus), 752 rufum (Spirillum), 852 rufum (Thiospirillum), 852 rufus (Bacillus), 644 rufus (Eruthrobacellus), 644 Ruga, 1218 rugatus (Micrococcus), 274 rugosa (Pseudomonas), 104, 700 rugosum (Achromobacter), 426 rugasum (Bacterium), 426, 703, 758 rugosus (Bacillus), 104, 426, 752 гидозиз (Micrococcus), 274 rugosus (Streptococcus), 343 rugosus ureae (Streptococcus), 343 rugula (Spirillum), 217 rugula (Vibrio), 217 rugulosus (Baccilus), 752 rummantum (Cowdria), 1094 rummantsum (Hemophilus), 591 ruminantium (Micrococcus), 274 ruminantium (Rickettsia), 1094 ruminantium (Rickettsia) (Cowdria), 1091 ruminatus (Bacellus), 714, 761 rumpel (Vibrio), 703

rubropertinclus (Bacillus), 392, 904

rushmorei (Micrococcus), 274 russii (Bacteroides), 580 rusticum (Bacterium), 761 rutgersensis (Actinomyces), 952 rutgersensis (Streptomyces), 952 rutilescens (Bacillus), 485 rutilescens (Erythrobacillus), 485 rutilescens (Serrotia), 485 rutilis (Bacıllus), 485 rutilis (Erythrobacillus), 485 rutilis (Serratio), 485

sabouraudi (Bacillus), 387 saccatus (Micrococcus), 275 socchari (Bocillus), 163, 478, 753 sacchari (Erwinia), 478 sacchari (Marmor), 1183 sacchari (Nanus), 1208 sacchariphilum (Bacterium), 762 saccharo-acetobutylicum (Clostridium). 781, 825

saccharo-acetobutylicum-alpha (Clostridium), 781, 825 saccharo-acetobutulicum-beta (Clostrid-

ium), 781, 825 saccharo-acetobutylicum-gamma (Clostrid-

1um), 781 Saccharobacillus, 349

Saccharobacter, 705 Saccharobacterium, 623

soccharobutyl - acetonicum (Clostridium), 781, 825 saccharobutylicum beta (Clostridium),

saccharobutylicum gamma (Clostridium), 781, 825

saccharobutyl - isopropyl - acetonicum (Clostridium), 781 saccharobutyricum (Clostridium), 771,

soccharobutyricum (Granulobacter), 771,

saccharobutyricum gamma (Clostridium),

saccharobutyricum liquefaciens (Clostrid-

1um), 790

saccharobulyricus (Amylobacter), 771 saccharobulyricus (Bacillus), 771, 786, saccharobutyricus immobilis liquefaciens (Granulobacıllus), 790, 826

saccharobutyricus immobile nonliquefaciens (Granulobacter), 772, 824 saccharobutyricus liquefaciens (Bacillus),

saccharobulyricus mobilis (Bacillus), 771 saccharobutyricus mobilis non-liquefa-

ciens (Granulobacillus), 771, 824 saccharofermentans (Bacillus), 817 saccharogenes (Bacillus), 817 saccharolactis (Streptococcus), 325 saccharolytica (Botulinea), 22

saccharolyticum (Clostridium), 785 saccharolyticus (Bacillus), 753 saccharopetum (Clostridium), 772, 824 saccharophile (Pseudomonas) (Hydro-

genomonas), 149 saccharophilicum (Clostridium), 772, 824 saccharopostulotum (Clostridium), 772,

824

saecharum (Bacillus), 478 saccobranchi (Bacillus), 753 sadowa (Myerillus), 823 saharae (Actinomyces), 973 saint paul (Salmonella), 504 soipan (Solmonella), 532 sake (Lactobacillus), 363 salicinovorum (Aerobacter), 457 saliciperda (Bacterium), 144 saliciperda (Phytomonas), 144 saliciperda (Pseudomonas), 144 salicis (Bacterium), 466 salicis (Erwinia), 466 salicis (Phytomonas), 466

salina (Leptospira), 1079 salinaria (Pseudomonas), 210, 442 salinaria (Serratia), 110

salinarium (Flavobacterium) (Halobacterium), 110

salinatis (Salmonella), 504 salivae (Bacterium), 686

salivae minulissimus (Bacillus), 686 salwae minutissimus (Bacterium), 656

```
ealivalis septicus (Micrococcus), 274
salivarius (Klebsiella), 306
salivarium (Bacterium), 307
salivarius (Micrococcus), 275
salivarius (Klaphylococcus), 282
salivarius (Stephylococcus), 282
salivarius (Stephylococcus), 320, 322,
```

338, 342 salivarius brevis (Streptococcus), 343

salivarsus septicus (Coccus), 275 salivarius-septicus (Micrococcus), 275 salivarius-septicus fels (Bacillus), 553 salivarsus tenurs (Streptococcus), 313 Salmonella, 10, 17, 21, 26, 91, 37, 43, 401, 492, 404, 408, 816, 523, 530, 531, 552

Salmonella sp. (Type Aberdeen), 499, 526
Salmonella sp. (Type Abony), 495, 502

Salmonella sp. (Type Adelaide), 500, 530 Salmonella sp. (Type Altendorf), 495, 506

Salmonella sp. (Type Amager), 493, 524 Salmonella sp. (Type Amersfoort), 496, 511

Salmonelia sp (Type Amberst), 497, 515 Salmonelia sp (Type Arecbavaleta), 495, 506

Salmonella sp. (Type Arizona), 462 Salmonella sp. (Type Ballerup), 500, 529

Salmonella sp. (Type Bareilly), 496, 511 Salmonella sp. (Type Berlin) (Type Thompson), 510

Salmonella sp. (Type Berta), 497, 518 Salmonella sp. (Type Bispehjerg), 495, 506

Salmonella sp. (Type Blegdam), 497, 518 Salmonella sp. (Type Borbeck), 499, 572 Salmonella sp. (Type Braenderup), 496, 511

511 Salmonelia sp. (Type Brandenburg), 495, 505

Salmonella sp (Type Bredeney), 498, 507

Salmonella ap. (Type Budapest), 495, 505

Salmonella sp. (Type Buenos Aires), 497, 514

Salmonella sp. (Type Butantan), 499, 524

Salmonella sp. (Type California), 495,

Salmonella sp. (Type Canastel), 498, 521 Salmonella sp. (Type Cardiff), 496, 512 Salmonella sp. (Type Carrau), 500, 528 Salmonella sp. (Type Cerro), 500, 529 Salmonella sp. (Type Champaign), 500.

530 Salmonella sp. (Type Chester), 495, 504 Salmonella sp. (Type Claiborne), 497,

Salmonella sp. (Type Concord), 496, 512 Salmonella sp. (Type Cuba), 493, 527 Salmonella sp. (Type Dar es Salaam).

493, 579
Salmonella sp. (Dar es salaam type var. from Arizona.), 462

Salmonella sp. (Type Daytona), 496, 513

Salmonella sp. (Type Derby), 495, 505 Salmonella sp. (Type Dublin), 497, 517 Salmonella sp. (Type Duesseldorf), 497, 514

Salmonella sp. (Type Durban), 497, 519 Salmonella sp. (Type Eastbourne), 498, 519

Salmonella sp. (Type Essen), 495, 505 Salmonella sp. (Type Florida), 500, 528 Salmonella sp. (Type Gaminara), 500.

529
Salmonella sp. (Type Gatun), 497, 515
Salmonella sp. (Type Georgia), 496, 512
Salmonella sp. (Type Give), 498, 522
Salmonella sp. (Type Give), 498, 522
Salmonella sp. (Type Goettingen), 497, 514
Salmonella sp. (Type Goettingen), 498.

520 Salmonella sp. (Type Grumpy), 499, 527 Salmonella sp. (Type Hartford), 496, 611

Salmonella sp. (Type Havana), 499, 527

sapolactica (Pseudomonas), 149 sapolacticum (Bacterium), 149 saponaccus (Bacillus), 668 saprogenes (Bacillus), 663, 753, 782, 817 saprogencs (Baclerium), 668 saprogenes (Lactobacillus), 263 saprogenes (Plectridium), 782 saprogenes (Streptococcus), 344 saprogenes 1 (Bacillus), 668 saprogenes 2 (Bacillus), 670 saprogenes I, II, III (Bacillus), 753, 782, saprogenes earnis (Bacillus), 782, 825 saprogenes intestinalis (Bacillus), 817 saprogenes vini I (Bacillus), 672 sapragenes vini II (Bacillus), 672 saprogenes vini III (Bacıllus), 753 saprogencs vini IV (Bacıllus), 638 saprogenes vini V (Bacıllus), 651 saprogenes vini VI (Bacillus), 668, 753 saprogenes vini I (Micrococcus), 280 saprogenes vini II (Microcoecus), 345 Sapromyees, 1204 saprophiles (Microspira), 202, 203, 206 saprophiles (Vibrio), 203 sapraphiles a (Vibrio), 202 sapraphiles & (Vibria), 202 saprophiles y (Spirillum), 202 saprophiles y (Vibrio), 202 saprophytica (Nocardia), 976 saprophyticus (Actinomyces), 934, 977 sapraphyticus (Bacillus), 817 saprophyticus (Streptococcus), 337, 344 saprophylicus var. cromogenus (Actinomyces), 977 Saprespira, 19, 20, 26, 28, 1064 saprotoxicum (Clostridium), 817 saprotoxicus (Bacillus), 817 sarcemphysematodes hominis (Bacillus), 821 Sarcina, 13, 14, 15, 17, 19, 21, 25, 27, 29, 31, 33, 42, 249, 285 sarcinaeformis (Pediococcus), 250 sarcinoides (Micrococcus), 274 sarcinoides (Nitrocystis), 75 sarcoemphysematodes (Clostridium), 821

sarcoemphysematodes hominis (Bacillus), sarcophysematos (Bacillus), 775, 776 sareophysematos bavis (Bacıllus), 775 sarcophysematos bovis (Clostridium), 775 sarcophysematosi (Bacillus), 776 sardinae (Bacillus), 483 sardiniensis (Clostridium), 821 sardous (Bacillus), 362 sardum miciurati (Bacterium), 362 sarracenicolus (Bacillus), 668 sartagoformum (Clostridium), 793 sartoryi (Actinomyces), 917 satellitis (Bacillus), 817 satellitis (Inflabilis), 817 sauromali (Bacterium), 461 savastanoi (Bacterium), 132 sarastanoi (Phytomonas), 132 savastanai (Pseudomonas), 132, 133 sarastanoi var. frazini (Bacterium), 132 savastanoi var. frazini (Phytomonas), 132 savastanoi var. frazini (Pseudomonas), 132 savastonoi var. nerii (Pseudomonas). 132 Savoia, 1221 saxicaçãe (Cristispira), 1057 saxicarae (Spirochaeta), 1057 saxkoebing (Leptospira), 1079 s. b. e. (Streptococcus), 343 scaber (Bacıllus), 753 scaber (Tyrothrix), 753 scabiegena (Erwinia), 478 scabiegenum (Bacterium), 478 seabiegenus (Bacıllus), 478 scabies (Actinomyces), 43, 957, 977 scabies (Oospora), 957 scabies (Streptomyces), 957 scariosus (Micrococcus), 275 scarlatinae (Bacillus), 668 scarlatinae (Micrococcus), 315 scarlatinae (Streptococcus), 315 scarlatinae (Streptus), 14, 315 scarlatinae (Syzygiococcus), 304 scarlatinae sanguinis (Diplococcus), 301, scarlatinosa (Perroncitoa), 275

scarlatinosus (Micrococcus), 275 scarlatinus (Micrococcus), 275 scatologenes (Bacillus), 817 acelestus (Erro), 1251 Scelus, 1234 echasteri (Bacillus), 445, 450 schaffers (Bacterium), 445, 450 schafferi (Escherichia), 445, 450 schoudings (Planesarcina), 293 schoudinni (Sarcina), 293 schaudinns (Spirochaeta), 1063 schaudinni (Spiroschaudinnia), 1063 schaudinni (Treponema), 1063 Schaudinnum, 12, 13, 705 scheurleni (Bacillus), 743 schirolikhi (Bacillus), 754 zehirokikhi (Raeterium), 442 schizokikhii (Flarobacterium), 412 schizobacteroides (Nitrospoloea), 73 schleissheim (Salmonella), 507 Schlerothrin, 12, 14, 876 Schmidlea, 870 schmidlei (Thioploca), 994 schmidts (Streptococcus), 344 schmitzri (Hacterium), 536 schmitzri (Shigella), 536 schallelii (Bacıllus), 753 schollelii (Bacterium), 753 shottmuelleri (Salmonella), 62, 495, 501, schottmülleri (Bacillus), 501 schottmüllers (Bacterium), 501 scholimülleri var. alrei (Salmonella), 532 achroeteri (Sorangium), 1021 schroeleri (Spirillum), 1054 schroeteri (Spirochaete), 1054 Schuetsia, 312 schuezenbachii (Bacterium), 187 schuffneri (Bacterium), 686 schutz (Streptococcus), 317 schülzenbergii (Bacıllus), 691 schulzenbergii I and II (Urobacillus), 691 schuylkıllıensis (Aerobacıllus), 722 schuylkilliensis (Microspira), 196 schuylkilliensis (Pseudomonas), 93, 700 schuylkilliensis (Vibrio), 196

schuylkilliensis fluorescens (Bacıllus), 93

schwarzenbeck (Streptococcus), 332 schwarzenerund (Salmonella), 507 scillearum (Marmor), 1184 scissa (Pseudomonas), 97, 700 scissus (Bacillus), 97 seizeus (Bacterium), 700 sciuri (Haemobartonella). 1107 schannei (Endosporus), 804 eclarni (Bacillus), 804 nclavoi (Clostridium), 804 scoticus (Bacellus), 668 scoticus (Erro), 1248 secales (Bacsllus), 457 secretum (Marmor), 1198 secundarius (Phagus), 1132 secundum (Clostridium), 821 secundus (Bacsllus), 668 secundus fullesi (Bacillus), 668 secundus fulless (Bactersum), 668 sedentarius (Micrococcus), 636 sedimenteur (Micrococcus), 698 secetalis (Bacillus), 753 seamentosum (Corvnebacterium). 408 segmentosus (Bactitus), 406 segnis (Pseudomonas), 177 seiferts (Streptococcus), 314 zelachsi (Treponema), 1076 selandia (Salmonella), 525 sciencus (Micrococcus), 275 Selenomonas, 218 Semiclostridium, 705 seminum (Bacterium), 138 seminum (Phytomonas), 133 seminum (Pseudomonas), 138 sempervivum (Bacterium), 755, 761 sendas (Salmonella), 493, 518 sendaiensis (Salmonella), 518 senegal (Salmonella), 526 senflenberg (Salmonella), 525 senftenbergensis (Salmonella), 525 senzibilis (Micrococcus), 275 sensitiva (Cytophaga), 1015 sepedonsca (Phytomonas), 393 sepedonscum (Aplanobacter), 393 sepedonicum (Bacterium), 393 sepedonicum (Corynebacterium), 393 sepiae (Photobacterium), 637

sepiola (Coccobacillus), 702 septatum (Bacterium), 401 septatum (Polyangium), 1023 septatum (Sorangium), 1023 septatum var. microcyslum (Sorangium). 1023 septatus (Bacillus), 401 septentrionale (Bacterium), 636 septica (Merista), 283 septica (Pasteurella), 546 septica (Pseudomonas), 94 septica (Sarcina), 283 seplicaemiae (Eberthella), 513 septicaemiae (Shigella), 543 seplicaemiae anserum exudativae (Bacillus), 543 seplicaemiae canis (Bacterium), 590 seplicaemiae hemorrhagicae (Bacillus). 546 seplicaemiae haemorrhagicae (Bacterium). septicaemiae lophuri (Bacıllus), 668 zepticaemicus (Bacillus), 668 septichaemiae (Bacterium), 547 septico-aerobius (Bacillus), 753 septicum (Bacterium), 673 septicum (Clostridium), 774, 775, 782, 815, 824 septicum (Microsporon), 275 seplicus (Aclinomyces), 917 septicus (Bacillus), 686, 774, 775, 817 septicus (Bacterium) (Proteus), 686 septicus (Coccus), 275 septicus (Micrococcus), 275 septicus (Proteus), 686 septicus (Streptococcus), 344 septicus (Tetracoccus), 283 septicus (Vibrio), 206, 775 septicus acuminatus (Bacillus), 674 septicus acuminatus (Bacterium), 674 septicus agrigenus (Bacillus), 673 septicus agrigenus (Bacterium), 673 septicus cuntculi (Bacıllus), 652 septicus gangrenae (Bacillus), 775 septicus hominis (Bacillus), 668 septicus hominis (Bacterium), 668

septicus insectorum (Bacillus), 753

seplicus leratomalaciae (Bacillus), 679 septicus liquefaciens (Streptococcus), 344 septicus putidus (Bacıllus), 667 septicus putidus (Bacterium), 667 septicus sputigenus (Bacillus), 306 septicus ulceris gangraenosi (Bacillus), septicus vesicae (Bacillus), 668, 741, 758 septimum (Clostridium), 822 septimus (Hiberillus), 822 septique (Clostridium), 775 septique (Vibrio), 775 septopyaemicus (Streptococcus), 344 septus (Bacillus), 406 Seguinillus, 11, 763 serbinowi (Bacıllus), 478 serbinowi (Bacterium), 478 serbinowi (Erwinia), 478 sergenti (Bartonella), 1106 sergenti (Haemobartonella), 1106 sericeus (Bacillus), 668 sericea (Pseudomonas), 149 serophilus (Micrococcus), 275 serositidis (Bacıllus), 727 serpens (Archangium), 1019 servens (Bacillus), 506 serpens (Bacteroides), 566, 577 serpens (Chondromyces), 1017, 1019 serpens (Spirillum), 213 serpens (Vibrio), 213 serpens (Zuberella), 568, 577 serranos (Bacterium), 127 Serratia, 5, 10, 14, 20, 25, 31, 32, 37, 443, 461, 479, 484, 705 serratum (Bacterium), 761 serratus (Actinomyces), 917 serratus (Bacillus), 668 serratus (Micrococcus), 275 serrulatus (Bacıllus), 753 aesami (Bacıllus), 137, 753 sesami (Bacterium), 128 sesami (Phytomonas), 128 sesami (Pseudomonas), 128, 137 sesamicola (Bacterium), 128 sesamicola (Phytomonas), 128 aessile (Bacterium), 716 aessile (Synangium), 1033

sessilis (Bacillus), 716 sessilis (Chondromyces), 1033 sessilis (Pseudomonas), 700 setariae (Bacterium), 126 setariae (Phytomonas), 126 setariae (Pseudomonas), 126 setiensia (Inflabilia), 823 setonii (Actinomuces), 973 setosum (Bacterium), 686 setosus (Bucellus), 668 sewanense (Bacterium), 435 sewanense (Flavobacterium), 435 sewerini (Bacterium), 761 sewerinii (Achromobacter), 426 sextum (Clostridium), 810 sextus (Hiblerilus), 810 shangani (Salmonella), 621 shermanii (Propionibacterium), 373, 374. 375, 378, 379 shigae (Bacillus), 536 shigae (Bacterium), 536 Shigella, 10, 26, 31, 37, 489, 492, 835, 537 shmamini (Fusocillus), 583 siglopous (Staphylococcus), 257 sialosepticus (Micrococcus), 275 stamensis (Bacillus), 716 sicca (Neisserra), 298, 299 siccum (Bactersum), 686 siceus Bacillus), 753 siccus (Bacteroides), 567, 579 siccus (Diplococcus), 298 siecus (Micrococcus), 275 siccus (Spherophorus), 567, 579 Siderobacter, 835 Siderocapsa, 9, 23, 26, 29, 35, 833 Siderococcus, 835 Sideroderma, 835 Sideromonas, 20, 23, 26, 29, 35, 834, 835 Sideromyces, 986 enderopous (Chlamydothrix), 985 sideropous (Gallianella), 832, 985 sideropous (Leptothrix), 985 Siderothece, 835 eseberti (Bacterium), 686 silberschmidii (Hacillus), 669 silberschmidti (Actinomyces), 975

silberschmidti (Nocardia), 975

silberschmidtii (Cohnistreptothrix), 975 silvaticus (Bacillus), 714 silvestria (Cutophaga), 1016 silvestris (Erro), 1249 sımıae (Bacterium), 693 simiae (Noguchia), 593 simile (Bacterium), 753 similis (Bocillus), 753 similis (Micrococcus), 275 simili uphosus (Bacillus). 753 simplex (Bacillus), 718, 748, 751 simplex (Corynebacterium), 397 simplex (Micrococcus), 275 simplex (Myzobacter), 1030 simplex (Polyangium), 1030 simplex (Rhizobium), 225 simsbury (Salmonella), 525 simulans (Bacillus), 609 simulans (Legio), 1260 simulans (Micrococcus), 275 emaguragus (Bacillus), 754 sinense (Butylobacter), 781, 825 ernensie (Spirochaeta), 1069 singulare (Acetobocter), 602 singularis (Bacillus), 669 sinuosa (Pseudomonas), 103, 700 sinuosum (Achromobacter), 103 sinuosus (Bacillus), 103 sinuosus (Bacterium), 700 esticulosus (Bacellus), 669 skoliodanta (Spirochaeta), 1074 skoliodontum (Treponema), 1074 smaragdina (Pseudomonas), 94, 700 smaragdino foetidus (Bacierium), 700 smaragdinaphasphorescens (Achromobacter), 631 smaragdino-phosphorescens (Bacillus), 634 smaragdino-phosphorescens (Bacterium). 634, 635 smaragdinum (Bacterium), 635 smaragdinus (Bacillus), 700 emaragdinus foelidus (Bacillus), 94 \*megmatis (Bacıllus), 890 smegmatia (Bacterium), 890 amegmatis (Mycobactersum), 800 smegmatis var. muris (Mycobacterium). 891

smithii (Chromobacterium), 234 smithii (Microspira), 206 smithii (Pseudomonas), 234 smithii (Vibrio), 202, 203, 206 smyrnii (Azotobacter), 219 snieszkoi (Plectridium), 823 sociovivum (Bacterium), 806 sodoku (Spirochaela), 215 sodoku (Treponema), 215 soehngenii (Methanobacterium), 645. 646 sogdianum (Borrelia), 1069 sogdianum (Spirochaela), 1069 sojae (Bacterium), 131 sojae (Phytomonas), 131 sojae (Pseudomonas), 131, 135 sojae (Rhizobium), 226 solanacearum (Bacillus), 137 solanacearum (Bacterium), 137 solanacearum (Phagus), 1135 solanacearum (Phytomonas), 137 solanacearum (Pseudomonas), 137, 138, 1129, 1135, 1136 solanacearum var. asiatica (Phytomonas). 133 solanacearum var asiatica (Pseudomonas), 13S solangcearum var. asiaticum (Bacterium), 138 solani (Acrogenus), 1203 solani (Butylobacter), 781, 825 solani (Chlorogenus), 1143 solani (Corium), 1204 solani (Marmor), 1174 solani (Sarcina), 293 solanı var. severus (Acrogenus), 1203 solani var. vulgaris (Acrogenus), 1203 solanincola (Bacillus), 469 solaniolens (Phytomonas), 98 solaniolens (Pseudomonas), 98 solaniperda (Bacillus), 477 solanisapra (Erwinia), 468, 469, 470 solanisaprus (Bacillus), 463, 470 solare (Bacterium), 439 solare (Flavobacterium), 439 solenis (Spirochaeta), 1057

solenoide (Spirosoma), 831

solida (Cornilia), 817 Solidococcus, 8, 235 Solidoribrio, 8, 192 solidum (Clostridium), 821 solidus (Bacillus), 817, 821 solitarium (Achromobacter), 426 solitarius (Bacillus), 426 solitarius (Bacterium), 426 solmsii (Bacillus), 817 solmsii (Diplectridium), 817 solt (Salmonella), 526 somaliensis (Actinomuces), 965 somaliensis (Discomyces), 965 somaliensis (Indiella), 965 somaliensis (Indiellopsis), 965, 966 somaliensis (Nocardia), 965 somaliensis (Streptomyces), 965 somaliensis (Streptothriz), 965 sombrosus (Bacillus), 751 sommeri (Actinomyces), 917 sommeri (Dospora), 918 sonnei (Bacterium), 540 sonnei (Prashigella), 540 sonnei (Shigella), 540, 542, 543 Sorangium, 1021 sardellii (Bacillus), 787 sordelli (Clostridium), 787 sordidus (Bacillus), 603 sordidus (Bacterium), 669 sordidus (Micrococcus), 275, 669 sorediatum (Polyangium), 1022, 1023 sorediatum (Sorangium), 1022 sorediatum var. macrocyclum (Sorangium), 1023 sorghi (Bacillus), 751 sorghi (Bactersum), 754 soriferum (Bacterium), 686 sornthalii (Microsoccus), 314 sornthalii (Streptococcus), 311 Sprochlorist, 869 sorracenicolus (Bac erium), 883 sotto (Bacillus), 754 satto (Bacterium), 751

soya (Bacterium), 358

sayae (Lactobacillus), 358

soyae (Leuconastoc), 316

soyge var. japonicum (Bacterium), 132

Starch hydrolysis feeble.

Ontimum temperature 25°C

Isolated in England from brown-spot of cultivated mushrooms

Habitat: Pathocenic on cultivated mushrooms.

ını Pseudomonas Yanth achiera (Schuster) Stano (Bacterium zanthochlorum Schuster, Arbeit a d Kaiserl Biolog. Anstalt. f. Land. u. Forstw., 8. 1912, 452; Phytomonas xonthochlara Bergev et al., Manual, 1st ed., 1923, 180, Stapp, in Sorager, Handbuch der Pflanzenkrankheiten, g. 5 Auf., 1928, 213 1 From Gr. zanthus, yellow, chlorus, green

Description from Ery: Smith, Bacteria in Rel. to Plant Dis . 3, 1914, 272

Rods 0.75 to 1.5 by 3.0 microns tile with 1 to 3 flagella. Gram-negative Green fluorescent nigment produced in culture

Gelatin: Slow hauefaction

Agar colonies. Circular, slightly raised. sellow white.

Broth. Strong clouding in 24 hours A white pellicle

Milk: Slow congulation and clearing Nitrites are produced from nitrates Indole is produced after 10 days

Hydrogen sulfide produced slowly Acid but not cas from glucose and

galactore. Optimum temperature 27°C Mayre

mum 44°C. Minimum 2°C Source Isolated Irom rotting potate

tubers in Germany.

Habitat, Pathogenic on rotato tubers and a number of nurelated plants

105 Pseudomonas rhizoctoria (Thora as) comb, nor. (Aplanobacter rhi:octoma Thomas, Olso Agr Exp Sta Bull 339, 1922, 211; Bacterium rhizocloma Stapp, in Sorager, Handbuch der Pffinzenkrank heiten, 2, 5 Aul., 1928, 200, Phytomonae rhizoctonia Burkholder, Phytopath , 20, 1930, 7.) I'rom Gr. rhizo, root; etonue, murder.

Rods, 0.5 to 0.85 by 1.4 to 1.9 microns Non motile. Gram negative

Green fluorescent mement produced in culture

Gelatin: Liquefaction

Nutrient ager colonies Greenish sol. low, later olive-buff, circular, raised, shehtly viscid.

Broth, Turbid, pyrite vellow

Milk. Alkaline, clears Natrites are produced from natrates

Indole reaction very slight No ILS formed

Starch: Potato starch slightly bydrawred

Growth in S per cent salt.

Ontinum temperature 25° to 27°C. Maximum 38°C Minimum 0°G

Source Isolated from roots of lettuce showing the rosette disease

Habitat: Pathogenic on roots of lettuce

166. Pseudomonas barkerl (Berridge) Clara Bacillus of pear blossom disease, Barker and Grove, Ann. Aupl. Biol . 1. 1914, 91; Barker and Grove's organism. Doidge, Ann Appl. Biol , 4, 1917, 50, B barkers Berridge, Ann. Appl Biol, 11. 1921, 73: Phytomonas barker, Bergey et al , Manual, 3rd ed , 1930, 265; Bacterrum barkers Cliott, Bacterial Plant Pathogens, 1930, 95; Clara, Science, 75. 1931, 11 ) Named for B. T. P Barker who first reported the species

Description from Doidge (loc eit.) Reds 05 to 08 by 2 to 4 microtis Motile with I to 4 polar flagella Grampegative (Burkholder), not Gram-positive as stated

Green fluorescent pigment produced in culture.

Gelatin Liquefaction

Agar Growth is white, leeble, Pet, elistening, smooth edged

Broth Slightly turbad in 21 hours

Milk Slowly cleared Natrites not produced from natrates Indole not formed unless culture

warmed. Starch slowly theested. Source Barker made many cultures

spurius (Bacillus), 754

sporogenes (Clostridium), 775, 782, 783, 784, 786, 817, 818, 825 sporogenes (Granulobacillus), 822 sporogenes (Laclobacillus), 763 sporogenes (Metchnikovillus), 782 sporogenes capsulalus (Bacillus), 817 sporogenes coagulans (Bacillus), 782, 825 sporogenes foetidus (Bacillus), 787, 818, sporogenes liquefaciens (Bacillus), 818 sporogenes non-liquefaciens (Bacillus), 818 sporogenes non liquefaciens anaerobius (Bacillus), \$18 sporogenes oedematis (Bacillus), 787 sporogenes parvus (Bacillus), 818 s porogenes psoriasis (Spirochaeta), 1069 sporogenes regularis (Bacıllus), 785 sporogenes saccharolyticus (Bacillus), 785 sporogenes var. A (Bacillus), 782 sporogenes var. A (Clostridium), 782 sporogenes var. A. P. Marie (Clostridium), 783 sporogenes var. B (Bacillus), 782, 787 sporogenes var. B (Clostridium), 787 sporogenes var. caudapiscis (Clostridium), 783 sporogenes var. equine (Clostridium). 783 sporogenes var. parasporogenes (Clostrid-1um), 784 sporogenes var tyrosinogenes (Clostridium), 783 sporogenes zoogleicus (Bacillus), 797 Sporonema, 6 sporonema (Bacıllus), 754 Sporosarcina, 30, 67, 285 Sporospirillum, 218 Sporotrichum, 916 Sporovibrio, 33, 35, 207 spumalis (Actinomyces), 976 spumalis (Oospora), 976 spumarum (Clostridium), 808 spumarum (Plectridium), 808 spumosum (Polyangium), 1031 spumosum (Sorangium), 1023

spumosus (Bacillus), 669

sputi (Bacillus), 754 sputi (Bacterium), 761 sputicola (Bacterium), 761 sputigena (Microspira), 198 spuligenes tenuis (Bacterium), 687 sputigenum (Bacterium), 686 spuligenum (Spirillum), 206, 218, 701 sputigenus (Streptococcus), 344 aputigenus (Vibrio), 198, 206 spuligenus var. minutissimus (Vibrio), 206 sputigenus crassus (Bacıllus), 459 sputigenus crassus (Bacterium), 459 sputorum (Vibrio), 206 squamiformis (Bacillus), 754 squamosum (Bacterium), 687 squamosum (Corynebacterium), 406 squamosum longum (Bacterium), 760, 762 squamosus (Bacillus), 669 squamosus longus (Bacıllus), 760 squatorolae (Treponema), 1076 stalactitigenes (Bacterium), 687 stanieri (Vibrio), 703 stanley (Salmonello), 503 stanlezi (Salmonella), 503 staphylina (Spirochaeta), 1069 Staphylococcus, 21, 31, 33, 235 staphylophagus (Micrococcus), 275 stations (Achromobacter), 421 stationis (Vibrio), 206 atearophilum (Achromobacter), 609 stearophilus (Bacillus), 600 stearothermophilus (Bacillus), 731 Stelangium, 1020 stellaris (Bacillus), 754 stellatum (Bacterium), 818 stellatum (Polyangium), 1031 stellatus (Bacillus), 580, 710, 754, 818 stellatus (Caccus), 276 stellatus (Micrococcus), 276 stellatus anaerobius (Bacillus), 818 stenogyrata (Spirochaeta), 1069 stenogycalum (Treponema), 1069 stenohalis (Achromobacter), 420 stenos (Streptococcus), 311 stenostrepta (Spirochaeta), 1053

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spatiosus (Bacillus), 754 spatuliforme (Cillobactersum), 369, 818 spatuliformis (Bacillus), 818 spermatozoides (Bacillus), 754 spermatozoides (Vibrio), 206 spermiformis (Treponema), 1076 spermoides (Acuformis), 812 spermoides (Bacsllus), 812, 827 spermoides (Clostridium), 812 apermoides (Palmula), 812 spermophilinus (Bacillus), 669 sphaerica (Blastocaulis), 836 sphaericum (Granulghacter), 822 sphaericus (Bacillus), 727, 723, 729, 818 sphaericus var. fusiformis (Bacillus), 728 Sphaerococcus, 312 sphaeroides (Chromatium), 816, 859 sphaeroides (Clostridium), 821 sphaeroides (Micrococcus), 275 aphaeroides (Rhizobium), 225 anhaerosporus (Bacillus), 754 sphaerosporus calco-acelicus (Bacillus), 754 Sphaerothrix, 986 Sphaerotilus, 12, 19, 23, 20, 982, 983 sphagns (Streptococcus), 344 aphenoides (Bacillus), 791 sphenoides (Clostridium), 791 sphenoides (Douglasillus), 791 aphenoides (Piectridium), 791 Spherocillus, 34, 38, 580 spheroides (Rhodopseudomonas), 865 Spherophorus, 31, 38, 578 sphingidis (Bacillus), 491 aphinoidis (Escherichia), 491 aphingidis (Proteus), 491

spiculifera (Cristispira), 1057 spiculifera (Spirochaeta), 1057 spieckermann (Bacillus), 477 apiniferum (Bactertum), 686 apiniferus (Bacillus), 686 apinosa (Cornifia), 817 spinosporus (Bacillus), 754 spinosum (Bacterium), 686 apinosua (Bucillus), 817 apirale (Bactersum), 686 spiralis (Actinomyces), 973

apiralis (Bacillus), 754 spirans (Bacillus), 669 Smrella, 28 Spirilina, 5, 486 spirilloides (Streptothrix), 977 SpiriBum, 5, 12, 15, 16, 18, 19, 21, 25, 28, 29, 31, 43, 212, 216, 996 spirillum (Azotobacter), 216 spirillum (Vibrio), 216 Spirobacellus, 12, 14 Spirochaeta, 5, 12, 18, 19, 20, 26, 28, 37, 1007, 1051, 1053, 1054, 1058 Spirochaete, 1051 Spirochoeta, 1951 Spirodiscus, 6 spirogyra (Bacillus), 754 Spiromonas, S. II Spironema, 20, 1058, 1071 Spirophyllum, 8, 9, 15, 17, 831 Spiroschaudinnia, 1058 Spirosoma, 7, 12, 16, 28, 212, 1122 Spiruling, 6, 993 spissum (Bacterium), 761 spitzi (Actinomyces), 925 spitzi (Brevistreptothriz), 925 spitzs (Discomyces), 925 spitzi (Oospora), 925 spiles (Streptothrix), 925 splendens (Bacillus), 613 splendidum (Photobacter), 636

sporegenes (Bacillus), 782, 817

splendidum (Photobactersum), 636

eplendor marss (Photobacter), 636

eplenomegaliae (Synbacterium), 580

Sporocytophaga, 35, 250, 1005, 1006,

sporagena rheumatisms (Spirochaeta),

splendidus (Vibrio), 636

spientea (Nocardia), 922 splenamegaliae (Bucteroides), 580

splenica (Actinomuces), 322

spongiosa (Phylomonas), 120

apangtasum (Bacterium), 120

sportferum (Spirillum), 218

1009, 1010, 1048

spongresus (Bacillus), 120, 754

apongrosa (Pseudomonas), 120

subcitricum (Bacterium), 687 subcloacae (Bacillus), 457 subcoccineus (Bacillus), 652 subcoccordeus (Bacillus), 669 subcreta (Cellulomonas), 176 subcreta (Pseudomonas), 176 subcretaceus (Micrococcus), 276 subcuticularis (Bacillus), 755 subdenticulatum (Bacterium), 762 subentericus (Bacillus), 533 suberfaciens (Bacterium), 640 suberfaciens (Phytomonas), 640 subfiliforme (Bacterium), 759 subflava (Neisscria), 276, 299 subflava (Sarcina), 293 subflavescens (Micrococcus), 276 subflavidus (Micrococcus), 278 subflavus (Bacillus), 669 subflavus (Bacterium), 660 subflavus (Diplococcus), 276 subflavus (Micrococcus), 276 subfectidus (Bacillus), 818 subfuscum (Bacterium), 687 subfuscus (Micrococcus), 276 subgastricus (Bacillus), 451, 669 subarlvus (Micrococcus), 277 subgranulatus (Sircrococcus), 277 subgranulosus (Bacillus), 658 suboriseus (Micrococcus), 277 subkiliensis (Bacillus), 484 sublacteus (Micrococcus), 277 sublanatus (Bacıllus), 755 sublilacinus (Micrococcus), 277 subliquefaciens (Bacterium), 457 sublustris (Bacillus), 755 subluteum (Bacterium), 687 subluteus (Micrococcus), 277 submarinus (Bacillus), 755 subniveus (Micrococcus), 251, 277 subochraceus (Bacillus), 670 subochraceus (Bacterium), 670 subochraceus (Micrococcus), 277 subovydans (Acetobacter), 184 subpneumonicum (Bacterium), 703 subroseus (Micrococcus), 274, 277 subrubeum (Bacterium), 762 subrubeus (Bacillus), 762

subrubiginosus (Bacillus), 670 subrufa (Serratia), 601 subrufum (Bacterium), 601 subsquamosum (Bacterium), 762 subsulcatus (Bacillus), 670 subterminale (Clostridium), 785 subterminalis (Bacıllus), 786 subterraneus (Micrococcus), 277 subterraneus (Staphylococcus), 277 subtetanicus (Bacillus), 727, 816 subthermophilum (Bacterium), 762 sublile (Bacterium), 755 subtile (Treponema), 1074 sublile agnorum (Bacterium), 643 sublitiforme (Bacterium), 755 subtiliformis (Bacillus) (Streptobacter) 755 subtilis (Bacillus), 42, 43, 45, 63, 708, 709, 711, 712, 713, 710, 741, 742, 746, 747, 751, 753, 760, 762, 1138 subtilis a (Bacillus), 710 sublilis (Bacellus), Michigan strain, 718 aubtilis (Mucrococcus), 277 aubtilis (Spirochaela), 1074 subtilis (Spironema), 1074 aubtilis (Spiroschaudinnia), 1074 subtilis (Vibrio), 710 sublilis var. asporus (Bacellus), 45 aubtilia var. aterrimus (Bacillus), 711 subtilis var. palleriae (Bacterium), 762 subtilis var. niger (Bacillus), 711 subtilis var. riscosus (Bacillus), 710 subtilis similis (Bacillus), 752 aubtilis simulans I (Bacillus), 755 subtilissimum (Spirillum), 206 subtrlissimus (Vibrio), 206 aubvertens (Phagus), 1138 aubviscosum (Bacterium), 414 succinicum (Bacterium), 452 succinicus (Bacillus), 755 succulentus (dlicrococcus), 277 sudaminis (Bactllus), 663 suffodiens (Morsus), 1153 suffuscus (Bacillus), 755 suscida (Bacterium), 518 suidae (Treponema), 1076 suills (Pasteurella), 547, 684

stenostrepta (Treponema), 1053 stercorario (Serratia), 485 stercoris (Mucobacterium), 888, 891 stercusis (Mucobacterium), 891 sternbermi (Bacıllus), 418, 687 sternbergii (Bacterium), 687, 819 steroidiclasium (Bacterium), 687 sterotronia (Pseudomanas), 700 sterensae (Alcaliacnes), 416 stewarti (Aplanobacter), 638, 1136 stewarti (Bacıllus), 638 stewartsi (Bacterium), 638, 1129, 1134, 1136 stewarti: (Phytomonas), 638, 1136 slewarti (Pseudomonas), 638, 1136 Stramatella, 1036 stinitatus (Myvococcus), 1043, 1044 stizolobii (Anlanobacter), 135 stizolobii (Bacterium), 135 stizolobii (Phytomonas), 135 stizolobii (Pseudomonas), 136 Stoddardillus, 11, 763 stolonatum (Flavobactersum), 442 stolonatus (Bacıllus), 442 stolonatus (Bacterium), 442 stoloniferum (Achromobacter), 715 stoloniferus (Bacillus), 715 stoloniferus (Bacterium), 715 stomnehr (Spirillum), 218 stomatitis (l'ibrio), 206 stramineus (Streptococcus), 344 strasburgense (Clostridium), 821 strasburgensis (Pasteurella), 554 strassmannı (Bacıllus), 669 streckers (Bacillus), 687 streckers (Bactersum), 687 streptobacilliformis (Bacteroides), 581 streptobacilli moniliformis (Musculomyccs), 1291 htreptobacillus, 319, 588, 763 Streptobacterium, 9, 30, 350 streptococci (Phagus), 1139 streptococci var virilis (Phagus), 1139 streptococciforme (Bacterium), 781 Streptococcus, 13, 14, 15, 17, 19, 21, 26, 27, 30, 31, 33, 43, 312, 313

Streptococcus No 52 313

Streptococcus en . 333, 334, 335 strentoforms (Bactllus). 754 Streptomyces, 588, 915, 929, 934, 967, 974 977 980 Strentathrix, 6, 929, 961, 977 Strentothrix No. 1, Almquist, 968 Streptothrix No. 2 and 3. Almquist, 934 Streptothrix sp., Donna, 916 Streptus, 14, 312 strinfaciens (Bacterium), 112 striafaciens (Phytomonas), 112 strafacions (Pseudomonas), 112 strata (Pseudomonas), 97, 700 struata (Sarcina), 293 striatum (Bacterium), 406 striatum (Corunebacterium), 406 strigtus albus (Bacillus), 406, 600 strictus flavus (Bocillus), 406, 669 striatus flavus (Bacterium), 406, 669 striatus viridis (Bacillus), 97, 669 steratus viridis (Bactersum), 700 strictus (Vibrio), 198, 206 strobiliformis (Micrococcus), 276 strumetides (Bacillus), 669 strumstis (Bacillus), 669 strumitis a(Bacillus), 669 strumitis & (Bacillus), 671 sturmanii (Haemobartonella), 1106 stutzers (Achromobacter), 426 stutzers (Bocsillus), 426 stutzeri (Bacterium), 426 stutzet: (Pseudomonas), 441 stylopygae (Spirochaeta), 1076 stylopygae (Treponema), 1076 suariorum (Legio), 1262 succeolens (Bacillus), 754 suavcolens (Fiavobacterium), 432 subacidus (Streptococcus), 344 subalbus (Bacillus), 623 subalbus var. batatatis (Bacillus), 623 subalcalescens (Bacultus), 451 subanaerobicus (Bacıllus), 720 subanaerobius (Bacıllus), 771 subcandscans (Microcaccus), 276 subcanus (Micrococcus), 276 subcarneus (Micrococcus), 255, 276 subertreus (Micrococcus), 276

syringae var. papulans (Phytomonas), 123 syringae populans (Phytomonas), 697 syzygios (Micrococcus), 304 syzygios searlatinae (Micrococcus), 304 szentes (Salmonella), 529

tabaci (Annulus), 1155, 1212, 1214, 1217 tabaci III (Bacillus), 755 tabaci (Marmor), 1155, 1164, 1167 tabaci (Musicum), 1164 tabaci (Phytomonas), 124 tabaci (Pseudomonas), 114, 124, 1134 tabaci (Ruga), 1216 tabaci var, artum (Marmor), 1166 tabacı var. aucuba (Marmor), 1166 labaci var. auralus (Annulus). 1213 tabaci var canadense (Marmor), 1166 tabacı var, deformans (Marmor), 1166 tabacı var. ımmobile (Marmor), 1166 tabacı var. kentuckiensis (Annulus), 1213 tabacı var. lethale (Marmor), 1166 tabacı var. obscurum (Marmor), 1166 tabaci var. plantaginis (Marmor), 1166 tabaci var. siccans (Marmor), 1166 labaci var. virginiensis (Annulus), 1212 tabaci var. vulgare (Marmor), 1166 tabacirorus (Bacıllus), 477 tabaeum (Bacterium), 124 tabidum (Flavobacterium), 691 tabificans (Bacillus), 477 tachusporus (Bacillus), SIS tachytonum (Bacterium), 687 tachytonus (Bacillus), 687 taeniaia (Gallionella), 831 taette (Laclobacillus), 695 taette (Streptobacillus), 702 taette (Streptococcus), 702 taksony (Salmonella), 525 talassochelys (Grahamella), 1111 talavensis (Bacıllus), 534 talavensis (Bacterium), 534 talavensis (Eberthella), 531 talavensis (Eberthus), 534 tallahassee (Salmonella), 514 talpae (Grahamelia), 1109 tangallensis (Bacillus), 544 tangallensis (Shigella), 544

tapetos (Cristispira), 1057 tapetos (Spirochaeta), 1057 taraxaci (Xanthomonas), 179 taraxeri cepapi (Actinomyces), 973 taraxeri cepapi (Streptothrix), 973 tarda (Eberthella), 534 tarda (Shigella), 514 tardicrescens (Bacterium), 638 tardicrescens (Phytomonas), 638 tardigradus (Micrococcus), 278 tardior (Micrococcus), 278 tardissima (Gaffkya), 284 tardissima (Neisseria), 278 tardissimus (Bacıllus), 670 tardissimus (Micrococcus), 278 tardissimus (Tetragenus), 284 tardivus (Bacıllus), 755 tardus (Bacillus), 544, 816 tardus (Micrococcus), 278 tarozzii (Actinomyces), 924 tarozzii (Streptothriz), 924 Tarpeia, 1268 tartari (Streptothriz), 977 tartarirorum (Aerobacter), 692 tartricus (Bacillus), 670 tareli (Bacillus), 727, 800, 816 technicum (Propionibacterium), 377 technicus (Bocillus), 755 tectum (Ochrobium), 835 tegumenticola (Bacterium), 604 tel-aviv (Salmonella), 529 telmatis (Bacillus), 670 temporariae (Spirochaeta), 1969 tenacatis (Micrococcus), 278 tenalbus (Multifermentans), 772 tenax (Bacillus), 755 tenax (Bacterium), 762 tener (Micrococcus) 278 tenerrimum (Spirillum), 206 tennessee (Salmonella), 512 tenua (Cristispira), 1057 tenuatus (Bacellus), 670 tenue (Bacterium), 687 tenue (Caryophanon), 1004 tenue (Clostridium), 821 tenue (Sideroderma), 835 tenue (Spirillum), 214

mulle (Switzehneta), 1069 suillum (Scelus), 1235, 1236 suipestifer (Bacillus). 508 sumestifer (Bacterium), 508 surpestifer (Salmonella), 45, 508 suis (Ramillus), 508 sus (Borreliota), 1232 suis (Brucella), 561, 562 suis (Corunebacterium), 406 suis (Hemophilus), 585, 586 surs (Micrococcus), 277 suis (Rickettsia), 1997 suis (Spirochaeta), 1963 suis (Spironema), 1063 suis (Tortor), 1275 auta (Vibrio), 206 surseplica (Pasteurella), 518 sursepirous (Bacillus), 548 sursepticus (Bacterium). 548 sulcatus (Bacillus), 670 súlcatus liquefaciens (Bacillus), 660, 670 suleatus liquefaciens (Bacterium). 670 sulfhydrogenus (Bacıllus), 670 Sulfomonas, 8, 29, 30, 78 Sulfospirillum, 29, 30, 212 sulfurea (Sarcina), 293 sulfureum (Achromobacter), 609 sulfureum (Bacterrum), 687 sulfureum (Flavobacterium), 610 sulfureus (Bacillus), 491, 687 sulfureus B-tardigradus (Micrococcus). 278 sulfureus (Proteus), 491 sulfureus var tardigradus (Micrococcus). 278 sulfurica (Thiospira), 702 sulphurata (Sarcina), 842 aulphurea (Consdothrix), 935 sulphurea (Leptothrix), 995 sulphurea (Nocardia), 925 sulphurea (Streptothrix), 925 sulphureus (Actinomyces), 925 aulphureus (Micrococcus), 277 sulphurica (Aphanothece), 572 sulphurien (Clathrochloris), 872 sumairae (Actinomyces), 916 sumniranum (Bacterium), 687

summeranus (Richeltsia), 1000 sundanali (Salmonella), 528 superba (Sarrana) 293 superficiale (Achromobacter), 420 superficialis (Bacillus), 420 superficialis (Racterium), 498) suppuratum (Corynebacterium). 406 supraresistens (Bacillus), 755 surats (Spirillum), 206 sweets (Tremonema), 206 sureti (Vihria), 202, 203, 206 surners (Bacsilus), 687, 755 surgers (Bacterium), 687 suspectus (Strentpenseus), 314 suspensa (Rhodocapsa), 854 suum (Pasteurella), 548 sucosiferum (Bacterium), 687 successferus feetides (Bacillus), 687 svivalagi (Molitor), 1244 symbiophiles (Bacillus), 580 sumbrotica (Escherichia), 427 sumbiotica (Sarcina), 203 symbioticum (Chlorobacterium), 873, 874 sumptomations (Bacillus), 776 Synangium, 1032 sunchuseus (Bacillus), 682 aunchuseus (Baetersum), 682 Syncrotis, 12, 13, 14, 365, 984 synevanea (Pseudomonas), 92, 700 syncyaneum (Bactersum), 92 suncuaneus (Bacillus), 92 syncyoneus (Vibrio), 92 syncyanus (Bacterrum), 700 Synechococcus, 996 synthetica (Vibrio), 206 synxantha (Pseudomonas), 700 synxanthum (Flavobacterium), 700 synxanthus (Bacillus), 700 synzanihus (Vibrio), 700 syphilidis (Bacillus), 687 syphilidis (Bacterium), 627 syphilities (Pacinia), 687 syphilitieus (Mierococcus), 276 syrangae (Bacterium), 119 syringue (Phylomomas), \$19

syringae (Fecudomonas) 119, 123

syringae vat. capsici (Bacterium), 120

tetragenus (Pediceoccus), 283 tetragenus (Planococcus), 284 tetragenus (Staphylococcus), 283 letragenus albus (Micrococcus), 283 tetragenus aureus (Micrococcus), 278 lelragenus citreus (Micrococeus), 280 tetragenus concentricus (Micrococcus), 278 letragenus febris flavae (Microcoecus), 280 tetragenus mobilis ventriculi (Micrococcus), 284 tetragenus pallidus (Micrococcus), 278 tetragenus ruber (Micrococcus), 214 tetragenus septicus (Micrococcus), 253 telrogenus subffarus (Micrococcus), 276 telragenus tersatilis (Micrococcus), 280 telragenus ervidus (Micrococcus), 279 tetraonis (Bacillus), 668 tetras (Micrococcus), 279 tetras (Pediococcus), 279 tetrylium (Clostridium) (Bacillus), 781, 825 tcutlia (Phytomonos), 613 teutlium (Aplanobacter), 613 teutlium (Bacterium), 613 texas (Salmonella), 500 thalassius (Achromobacter), 418 thalassokoiles (Baesllus), 756 thalassophilus (Bacillus), 720, 727, 818 thamnopheos (Mycobacterium), 883, 885, 880, 887, thaateri (Archangium), 1019 thaxter: (Chondromyces), 1033 thatteri (Synangium), 1033 theae (Bacillus), 756 Theetobactrum 12, 13, 705 theileri (Borrelia), 1062, 1066, 1068 theileri (Spirillum), 1062 theileri (Spirochaete), 1062 theilers (Spironema), 1062 theileri (Spirovchaudinnia), 1062 theileri (Treponema), 1062 Theileria, 1089 thermalis (Chlamydothrix), 986 thermalis (Leptothrix), 980 thermitanus (Thiobacullus), 81

thermoabundans (Bacıllus), 756

thermoacctigenitus (Bacillus), 756

thermoscidificans (Bucillus), 756

thermoocidophila (Palmula), 821 thermoacidophilus (Acuformis), 821 thermoacidophilus (Clostridium), 821 thermoacidurans (Bacillus), 712 Thermonctinomyces, 978 thermoactirus (Bacillus), 756 thermoaerogenes (Caduceus), 821 thermoacrogenes (Clostridium), 821 thermoalimentophilus (Bacillus), 735 thermoamylolyticus (Bacillus), 729 thermoannulatus (Bacillus), 750 thermoaquatilis (Bacillus), 750 thermoarborescens (Bactilus), 756 Thermobacterium, 9, 30, 350, thermobulyrosus (Bacillus), 756 thermocellulolyticus (Bacillus), 735 thermocellulolyticus (Terminosporus), 823 thermocellum (Clostridium), 821 thermocellus (Terminosporus), 821 thermochornus (Clostridium), 821 thermocompactus (Bacillus), 756 thermodoclylogenilus (Bacıllus), 736 thermodesulfuricans (Vibrio), 208, 209, thermodiastalicus (Actinomyces), 934, 974 thermodiastaticus (Bacillus), 732 thermodoratus (Baeillus), 756 thermodurica (Sercina), 291 thermoeffervescens (Bacillus), 756 thermofaecalis (Bacillus), 756 thermofibrineolus (Bacıllus), 756, 818 thermofiliformis (Bacillus), 756 thermofuscus (Actinomyces), 957 thermofuscus (Streptomyces), 957 thermograni (Bacillus), 756 thermoindifferens (Bacillus), 730, 731 thermoliquefaciene (Bacillus), 735 thermolongus (Eucillus), 756 thermolubricans (Bacillus), 756 thermononliquefaciens (Bacillus), 734 thermononodorus (Bacillus), 756 thermonubilosus (Bacillus), 756 thermopellitus (Bacillus), 758 thermophila (Nocardia), 957 thermophila & (Ristella), 576 thermophila y (Ristella), 576 thermophila (Sarcina), 294

:

----

tenue (Spirophyllum), 831 tenue (Trenonema), 1070 tenue altreum (Trenanema), 1068 tenuis (Actinomuces), 922, 974 tenus (Racillus), 670, 709 temus (Racteroides), 818 tenus (Clonothrax), 983 tennis (Cohnistrentothern), 922 tenuis (Crenothrax), 983 tenuis (Discomuces), 922 tenuts (Leptothrix), 385 tenuis (Mierococcus), 307 tennis (Noenrdia), 922 tenus (Pseudoleptothrix), 365 tenuis (Pseudomonas), 149, 701 tenuis (Surachaeta), 1070 tenuis (Streptococcus), 343, 344 tanus (Thiothris), 989, 990, 995 tenus (Tweethers), 700 tenuts (Vibrio), 206 tenus acuminata (Smrochaeta), 1064 tenus ans (Bacillus), 670 tenus olycolyticus (Bacillus), \$18 tenuis non-liquefaciens (Hacillus), 755 tenusa obtusa (Spirochaeta), 1068 tenuis apatuliformis (Bacillus), 369, 818 tenuts apulicenes (Bacillus), 607, 687 tenussima (Cytophaes), 1013 tenussema (Thiothrix), 990, 995 lenuissimus (Micrococcus), 259, 278 teras (Bocillus), 818 terus (Inflabilis), 818 terebrans (Bacıllus), 575 terebrans (Ristella), 575 teres (Barillus), 42 718 terminalis (Bacillus), 755 terminalis var thermophilus (Bacillus), 755

terminalis (1921-1113), 105 literiminalis var thermophius 755
Terminosporus 33, 31, 763
termitidis (Fusiformis), 283
termitidis (Fusiformis), 1070
termitis (Fusiformis), 1070
termitis (Treponema), 1070
termitio (Bacillus), 685
termio (Bacillus), 685
Termiodicterum), 157

terma (Manns) 687 termo (Zoooloea), 348, 687 termo var. subterraneum (Bacterium), 688 termonhelum (Bactersum), 757 ternisation (Cutonhaga), 1013 terras (Bacterum), 762 terrae (Strentabacillus), 762, 823 terrestralgingum (Bacterium), 642 terrestria (Barrillus), 756 terricola (Lactobacterium), 364 terricola (Strentococcus), 344 terr gena (Microspira), 207 terrogensum (Spirillium), 207 terrigenus (Borillus), 670 terrigenus (Vibrio), 207 tertium (Clostridium), 812, 827 tertsum (Plecirsdium), 812 tertium (Scelus), 1237 tertius (Bacillus), 812 tertius (Henrillus), 812 tertius (Phagus), 1137 testabilis (Phagus), 1138 testudinis (Mucobacterium), 591 testudo (Mycobacterium), 891 tetani (Bacillus), 783, 798 tetani (Clostridium), 43, 727, 798 tetans (Nicollaterillus), 799 tetans (Plectridium), 798 tetanoides (Bacillus), 756, 799 tetanordes (A) (Bacillus), 798 tetanoides (B) (Bacillus), 799, 826 tetanoides (Clostridium), 798 tetanomorphum (Clostridium), 800, 826 tetanomorphum (Plectridium), 800 tetanomorphus (Bacillus), 800 tetanomorphus (Macintoshillus), 800 Tetracklorss, 869 Tetracoccus, 9, 235, 283, 284 Tetradiplococcus, 283 tetragens (Gaffyka), 253, 258, 261, 267, 269, 270, 274, 275, 276, 278, 279, 281, 233, 234 tetragena (Merista), 283 tetragena (Sarcina), 283, 284, 292 tetragenes angerobius (Micrococcus), 284 tetragenus (Micrococcus), 283, 284

letragenus (3I ycococcus), 891

Thiospirillopsis, 993 Thiospirillum, 15, 16, 23, 25, 29, 850, 851, 852, 853 Thiothece, 16, 23, 25, 29, 845, 846, 849 Thiothrix, 16, 18, 19, 24, 26, 988, 989, 991, Thiovibrio, 15, 16 Thiovulum 15, 16, 996, 999, 1000 thiryei (Nocardia), 917 thiryi (Actinomyces), 917 thirm (Discomyces), 917 thjoettae (Actinomyces), 927 thoenii (Propionibacterium), 374, 377, tholocideum (Bacterium), 688 thologideus (Hacillus), 688 thompson (Salmonella), 510 thomson: (Micrococcus), 303 thoracis (Bacillus), 757 thuilliers (Actinomyces), 410 thuillieri (Bacillus), 410 thuilliers (Nocardia), 410 thuilliers (Pasteurella), 410 thuringiensis (Bacillus), 716, 759 thuringiensis (Bacterium), 716 tilsitense (Plocamobacterium), 631 tım (Salmonella), 525 tingens (Bacillus), 670 trogense (Achromobacier), 426 tiogensis (Bacillus), 426 tiogensis (Bacterium), 426 Tissieria, 20, 21, 22, 23, 27 Tissterillus, 11, 763 tizzonii (Bacterium), 553 tolaası (Bacterium), 128 tolaasıı (Phytomonas), 128 tolaasii (Pseudomonas), 128 tolega (Coccobacillus), 702 tolerans (Phagus), 1139 toluolicum (Bacillus), 670 tomato (Bactersum), 113 tomato (Phytomonas), 113 tomato (Pseudomonas), 113, 1136 tomentosum (Bacterium), 718 tommasoli (Micrococcus), 257 tonelliana (Phytomonas), 132 tonelliana (Pseudomonss), 132

tonellianum (Bacterium), 132 tonsillaris (Microspira), 207 tonsillaris (Vibrio), 207 tonsillaris (Vibriothrix), 218, 833 Tortor, 1275 tortuosa (Gallionella), 832 tortuosum (Bacterium), 688 tortuosum (Eubacterium), 367 tortuosus (Bacillus), 367, 688 tortuosus (Bacteroides), 367 Torula, 179 torulosum (Rhizobium), 223 tossicus (Actinomyces), 918 tostus (Bacillus), 736 toulonensis (Vibrio), 207 toxicatus (Micrococcus), 279, 341 toxicatus (Streptococcus), 314 toxigenus (Bacillus), 670 toxinogenes (Clostridium), 822 toyamenis (Pseudomonas), 637 tracheiphila (Erwinia), 467, 468 tracheiphilus (Bacillus), 467 tracheiphilus (Bacterium), 467 tracherphilus var. cucumis (Bacellus), 468 trachestis (Bacellus), 757 trachomae (Ricketlssa), 1114 trachomatis (Bacillus), 590 trachomatia (Chlamydozoon), 1114, 1115 trachematis (Micrococcus), 279 trachomatis (Rickettsiae), 1114 trachomatis conjunctivae (Micrococcus), 260 tralucida (Cellulomonas), 106 tralucida (Pseudomonas), 106 trambust: (Bacterium), 670 trambustri (Bacıllus), 670

163
translucens f. sp. hordei (Xanthomonas),
162
translucens f. sp. hordei-arenae (Xanthomonas),
163

thermorbilum I (Racterium), 760 thermophilum II (Bacterium), 736 thermanhilum III (Bacterium), 761 thermontalum IV (Rocterium), 762 thermonhilum V (Racterium), 760 thermophilum VI (Bactersum), 760 thermophilum VII (Bactersum), 762 thermophilum VIII (Bacterium), 759 thermophilum (Clostridaum), 777, 821 thermontelum (Cocenhactersum), 693 thermanhilum (Denstrobacterium), 690, 762 thermophilus (Actinomices), 931, 956 thermophilus (Bacillus), 670, 736, 757, 777 thermophilus I (Bacillus), 760 thermophilus II (Bacillus), 736 thermophilus III (Racillus), 761 thermonkelus IV (Baccillus), 762 thermophilus V (Bacillus), 760 thermophilus VI (Bacillus), 760 thermophilus VII (Bacillus), 762 thermophilus VIII (Bacillus), 759 thermophilus a (Barillus), 819 thermophilus & (Bacillus), 576 thermophilus - (Bacillus), 576 thermophilus (Caduceus), 819 thermophilus a (Caduceus), 819 thermophilus (Corunebacterium), 406 thermophilus (Lactobacillus), 355 thermophilus (Micrococcus), 279

762
thermophilus (Streptococcus), 322
thermophilus (Streptomyces), 956
thermophilus anaerobicus (Bacillus), S21
thermophilus aquatilis liquefaciens
(Bacillus), 233

thermophilus (Nitrosobacillus), 76, 690,

(Bacillus), 733
thermophilus jitom (Bacillus), 732
thermophilus jitom (Bacillus), 732
thermophilus suquelis (Bacillus), 737
thermophilus suquelis (Bacillus), 757
thermophilus soque (Bacillus), 757
thermophilus rangense (Bacillus), 733
thermoputrifica (Palmida), 821
thermoputrifica (Clastridium), 821
thermoputrificus (Leuformis), 822
thermoputrificus (Leuformis), 822
thermoputrificus (Clastridium), 797

thermasaccha valuticus (Terminosnorus). 707 thermosuavis (Racillus), 757 thermotenaz (Bacillus), 757 thermotolerans (Actinomyces), 974 thermotransluceus (Bacillus), 734 thermouringlis (Bacillus), 757 thermoviscidus (Bacillus), 757 theta (Bacillus), 670 theta (Bacterium), 670 thetarotanmicron (Bacillus), 572 thetaiotaomicron (Bacteroides), 572, 580 thetarotaomicron (Spherocillus), 572, 580 thetoides (Bacillus), 566 thibierget (Actinomuces), 928 thibierges (Cohnistreptothrix), 928 thibierges (Discomuces), 928 Unbierges (Nocardia), 928 thibierges (Oosporg), 928 Thiobacillus, 15, 18, 20, 30, 69, 78, 81, 688, 839 Thiobacterium, 15, 17, 78 Thiocapsa, 16, 23, 25, 844, 849 Thiococcus, 8 Thiocystis, 16, 23, 25, 847, 848, 849 Thioderma, 16, 23, 25, 849 Thiodictyon, 16, 23, 26, 845 thiogenes (Bacterium), 688 Thiomongs, 8 Thronema, 995 throoxidans (Sulfomanas), 79 thiogridans (Thiobacillus), 79, 81 throoxydans (Throbacterrum), 79 thioparus (Sulfomonas), 79 thioparus (Thiobacillus), 79, 81 Thropedia, 16, 29, 843, 844 Thiophysa, 16, 24, 25, 996, 997 Thioploca, 15, 16, 19, 21, 26, 993 Thuopolycoccus, 16, 23, 25, 29, 650 Theoporphyra, 859 Thierhodospirillum, 16, 850 Thiosarcina, 16, 23, 25, 29, 642 Thromphon, 995, 996 Thiosphaera, 16, 23, 25, 846

Thiosphaerella, 15, 16, 996, 997

Thiosphaerson, 16, 23, 25, 859

Thiospira, 21, 25, 35, 212, 853, 996

from blighted pear blossoms. Doidge received a culture from Barker.

Habitat: Couses a blossom blight of pear.

107. Pseudomonas gladioli Severini. (Severini, Annalı d. Bot., Rome, 11, 1913, 420; Bacterium gladioli Elliott, Bact. Plant Pathogens, 1930, 132; Phytomonas gladioli Magrou, in Hauduroy et al., Dict. d. Bact Path , Paris, 1937, 356.) From L. gladiolus, a little sword; M. L. Gladiolus, a generic name.

Rods · 0 6 by 2 3 to 2.8 microns. Motile with one or more polar flagella. Gram-negative.

A pale yellow water-soluble pigment

found, later orange. Gelatin colonies. Cream-colored, wart-

like. Rapid liquefaction. Milk: Coagulated and slowly pep-

tonized. Nitrites not produced from nitrates.

Indole not formed.

No gas.

Aerobic.

Optimum temperature 25° to 30°C. Habitat: Causes a corm rot of gladiolus and other tubers.

108. Pseudomonas mellea Johnson. (Bacterium melleum Johnson, Jour. Agr. Res., 25, 1923, 489, Johnson, loc. cit., 489; Phytomonas mellea Bergey et al . Manual. 3rd ed., 1930, 251.) From L. melleus, of or belonging to honey, the color of the colonies.

Rods: 06 by I.8 microns. Capsules Motile with 1 to 7 polar flagella. Gramnegative.

Green fluorescent pigment produced in culture.

Gelatin: Liquefied.

Potato - glucose agar: Ahundant

growth, smooth, glistening, viscid, honeycolored Broth: Turbid in 24 hours. Pellicle

Milk: Alkalına; clears.

Nitrites not produced from nitrates Indole not formed.

Nn H2S formed.

Starcb hydrolysis feeble.

Growth inhibited by 4 per cent salt. Optimum temperature, 26° to 28°C. Maximum 36°C.

Fucultative anaerobe.

Distinctive character: Differs from Pseudomonas pseudozoogloeae in that it produces an tobacco a brown instead of a black spot with a halo, is orange-yellow in culture, and turns milk alkaline. Source: Isolated from brown rusty

spots un tobacco in Wisconsin.

Habitat: Pathogenic on leaves of tobacco. Nicotiana tabacum.

Pseudomonas betlis (Ragunacomb. nov. (Bacterium than) Ragunathan, Ann. Roy. Card., Peradeniva, Ceylon, 11, 1928, 51; Aplanobacter betle Elliott, Bact. Plant Pathogens, 1930, 4; Phytomonas bellis Magrau, in Hauduroy et nl., Dict. d. Bact. Path., Paris, 1937, 337.) From Malayan, betle, betel, a kind of pepper, Piper betle.

Rods: 0.5 by 1.5 to 2.5 microns, occurring singly or in sbort chains. Nonmotile. Gram-negative.

Green pigment formed in nutrient gelatin and in brotb.

Gelatin: Liquefaction.

Bovril agar colonies: Honey-yellow, eircularnt first, later echinulate. Raised, smooth and shiny.

Brotb: Surface becomes cloudy in 2 days. Pellicle.

Nn gas from lactose, maltose or sucrose. Starch is reduced.

Aerobic.

Source: Five cultures isolated from leaf spnts on the betel vine.

Habitat: Pathogenic on the betcl vine, Piper betle.

Pseudomonas panacis (Takimoto) (Bacterium panaxi Nakata Dowson. and Takimoto, Bul. Agr. Sta. Chosen, 5, 1922. 1: Phytomonas panaxi Magrou, in Haudurny et al., Dict. d. Bact. Path., Paris, 1937, 389; Dowson, Trans. Brit. translucens f. an. secalis (Xanthamanus). 162

translucens f. sp. undulosa (Xanthomonas), 162

translucens var. phlespratensis (Xanthomores) 703

translucens var. secolis (Racterium), 162 translucens var. secalis (Phytomogas), 162 translucens var. secalis (Pseudomonos).

translucens var. undulosa (Photomanas).

translucens var. undulasa (Pseudamanas).

translucens var. undulasum (Bacterium).

162 transvalensis (Actinomyces), 906 transvalensis (Nocardia), 906 trapanicum (Bacterium), 412

trapanicum (Flavobactersum) (Hala-

bacterium), 412 trautweinii (Thiobacillus), 81, 683 tremaergasius (Bacillus), 670 tremelloides (Bacillus), 442 tremelloides (Bactersum), 412 tremelloides (Flavobactersum), 412 tremulans (Bacillus), 688

tremulans (Bactersum), 688 tremulans (Vibrio), 688

Treponema, 12, 19, 20, 26, 28, 34, 35, 1071 treubii (Sideracapsa), 833

tributyrus (Micrococcus), 279 tricalle (Treponema), 1076 Trichobacterium, 28

trichodectae (Richettsia), 1097 trichogenes (Leptothrix), 984 trichoides (Bacillus), 576

trichoides (Bacteroides), 576 trichoides (Ristella), 576 trichorrhexidis (Bacterium), 688 Trickothecrum ap., 919

tricolor (Actinomyces), 935 tricomsi (Bacillus), 757 tricomii (Bacterium), 757 trifoliatus (Streptococcus), 311

trifolii (Bacıllus), 757

trifolis (Flasobactersum), 173

trifolii (Martnar), 1187 trafolti (Panadomanas) 173

trifolis (Rheschum) 225, 226 trefalsacum (Racterium) 120 trifaliarum (Phytomonas) 120

trifoliorum (Pseudomonas), 120 Trefur. 1282

triolae (Trenonema), 1076

testoculare (Racterium), 5, 596, 597 trimeres (Spirochaeta), 1079 tramerodonto (Lentospira), 1079

termerodanta (Spirochaeta), 1079 tramethulamen (Bacillus), 671

testica (Rocallius) 639 tritici (Bacierium), 400

tritici (Corvnebacterium), 400 tritica (Fractilinea), 1161

tritici (Marmor), 1192 tritici (Micrococcus), 279

tritici (Phytomonos), 400 tritics (Pseudomonas), 400, 639

tritus (Bacillus), 757 trommelachidael (Racsilius), 149

trammelschlägel (Pseudomonas), 149 fronicus (Aurococcus), 250

tromeus (Boeillus), 716 tromdonatum (Mucobactersum), 885

trapidoneti (Spirochaeta), 1070 tropidonoti (Spironema), 1070 tropiduri (Treponema), 1076

truffault (Bacellus), 710 truncatum (Bactersum), 321, 688, 762

truttae (Bacillus), 671 tsutsugamushi (Rickettsia), 1089, 1090, 1001

tsutsugamusks (Theileria), 1089

tsutsuoamushi-orientalis (Richettera). 1090

tuberculatum (Photobacter), 637 tubercultiarmis (Bacillus), 369 tuberculifarmis intestinalis (Bacillus),

tuberculorum (Cladocutrium), 221 tuberculosis (Bacillus), 877 tuberculosis (Bacterium), 877 tuberculosis (Coccothrix), 877 tuberculasis (Discomyces), 277

tuberculasis (Eumyces), 877 tuberculosis (Mycobacterium), 877 tuberculosis (Sclerothriz), 877 tuberculosis typus bovinus (Mycobacterium), 879 tuberculosis typus gallinaceus (Mucobacterium), 879 tuberculosis typus humanus (Alycobacterium), 877 tuberculosis var. bovis (Mycobacterium), 878, 879 tuberculosis var. hominis (Mycobacterium), 877, 878, 879 tuberculosis avium (Bacillus), 879 tuberculosis arrum (Mycobacterium), 879 tuberculosis gallingrum (Bacillus), 879 tuberculosia piscium (Bacillus), 883 tuberculosia zoogloeicae (Bacillus), 550 tuberculosus (Micrococcus), 279 tuberigenus (Bacillus), 225 tuberigenus 2 (Bacıllus), 657 tuberigenus 3 (Bacillus), 663 tuberiginus 4 (Bacillus), 656 tuberigenus 5 (Bacillus), 689 tuberigenus 6 (Bacillus), 678 tuberigenus 7 (Bacillus), 661 tuberigenus (Micrococcus), 225 tuberis (Bacillus), 757 tuberosa (Microspira), 837 tuberosum (Bacterium), 688 tuberosum (Photobacterium), 637 tuberosus (Bacillus), 688, 757 tubifex (Bacillus), 757 tularense (Baeillus), 551 tularense (Bacterium), 551 tularense (Coccobacterium), 551 tularensis (Brucella), 551 tularensis (Pasteurella), 551 tulipae (Marmor), 1182 tumefaciens (Agrobacterium), 227, 228 229, 1129, 1134, 1135 tumefaciens (Bacillus), 227, 775, 824 tumefaciens (Bacterium), 227 tumefaciens (Clostridium), 775 tumefaciens (Phytamonas), 227 tumefaciens (Polymonas), 228 tumefaciens (Pseudomonas), 227

tumescens (Bacillus), 632, 714, 715 tumescens (Corynebacterium), 397 tumescens (Zopfiella), 714 tumida (Ristella), 571, 576 tumsdue (Bacillus), 671 tumidus (Bacteroides), 571, 576 tumoris (Molitor), 1242 tumoris (Phagus), 1134 turbidans (Acetobacter), 189 turbidus (Streptococcus), 344 turbidus (Vibrio), 703 turcosa (Bacillus), 175 turcosa (Pseudomonas), 175, 701 turcosum (Bacterium), 688 tureosum (Flavobacterium), 175 turgescens (Bacterium), 716 turgidum (Bacterium), 761 turardus (Bacillus). 757 turgidus (Tyrothrix), 757 turicatae (Borrelia), 1064 turicatae (Spirochaeta), 1064 tuesis conculsitae (Bacillus), 589, 737 tussis contulsitae (Bacterium), 586, 589, tympani-cuniculi (Bacillus), 757, 818 typhi (Acystra), 515 tuphi (Bactlius), 515 typhi (Bactersum), 515 typki (Bocterium) (Eberthella), 515 typhi (Corynebacterium), 368, 387, 406 typhi (Dermacentrozenus), 1085, 1087 tuphi (Eberthella), 515 typhi (Rickettsia), 1085, 1086, 1087, 1988, 1090 typhi (Salmonella), 493, 515 typhi abdominalis (Bacillus), 515 typhicus (Bacillus), 701 typhiezanthematici (Bacillus), 405 typhi-exanthematici (Bacterium), 406 typhi exanthematics (Corynebacterium), 406 typki ezanthematici (Eubacterium), 368, typhi-exanthematici (Fusiformis), 408, typhi flavum (Bacterium), 533 typh: gallinarum (Bacillus), 520

tunki pallinarum alcalifaciens (Bacillus). 590 . ... /D If 1 FOR 502. 503, 511, 523, 669 tuphimurum (Type Binns) (Salmonella). tuphi-murum var. Binns (Salmonella). 503 tuphimurium var Copenhagen (Salmonella) 503 ivonisuis (Racillus), 503 tuphi-suis (Bacterium), 509 typhisuis (Salmonella), 496, 509, 510 typhiquis var. Voldagsen (Salmonella). 503, 510 (uphoideus (Micrococcus), 279 tuphosa (Eberthella), 45, 515 typhosa (Salmonella), 492, 493, 497, 515, 516, 521, 533, 701, 1130, 1137 tuphosum (Bacterium), 515 typhosus (Bacillus), 515, 659, 1137 typhosus (Eberthus), 515 typhosus (Vibrio), 515

tyrobulyneum (Clostridium), 772, 824
tyrogena (Microspira), 196
tyrogena (Spirilum), 190
tyrogenau (Spirilum), 190
tyrogenau (Streplococcus), 344
tyrogenau (Streplococcus), 344
tyrogenau (Microspira), 202
tyrosinogenae (Bacillus), 711, 788
tyrosinogenae (Clostridium), 783
Tyrothriz, 349, 737, 750, 763
Tyrothriz, 349, 737, 750, 763
tyretr (Bartonella), 1165

tyzzeri (Haemobartonella), 1105

ubers (Streptococcus), 335, 336 ubicularius (Bacsilus), 757 ubiquitum (Achromobacter), 426 ubiquitum (Bacsilus), 426 ubiquitus (Bacsilus), 426 ubiquitus (Bacsilus), 426 uda (Cellulomonas), 614 udar (Bacterium), 614 ufireduxii (Bacsilus), 671 ugonda (Salmonella), 582 ukili (Bacsilus), 588 ukılii (Clostridium), 818 ukrainica (Bartonella), 1108 ukrainzea (Haemobartonella), 1108 ulceria (Micrococcus) 279 pleeris (Seeling) 1238 ulcens concresi (Bacillus), 587 uleeris cancrosi (Bacterium), 587 ulceris mallis (Micrococcus), 279, 341 ulceronenes (Corunebacterium), 406 uligmosum (Flavobacterium), 630 ulmi (Micrococcus), 279 olmi (Morsus), 1154 ulna (Bacillus), 671, 757 Ulring, 25, 27, 179 umbelliferarum (Marmor), 1176 umbilicatus (Racilius), 671 umbilicatus (Micrococcus), 270 Umbing, 179 umbonatus (Thiebacillus), 81 uncata (Ristella), 569, 576 uncatus (Bacteroides), 569, 576 undula (Spirillum), 213 undula (l'abrio), 213 undula majus (Spirillum), 215 undula minor (Spirillum), 213 undulata (Holospora), 1122 undulata (Pzeudomonas), 149 undulata (Spirochaeta), 1062 undulatum (Treponema), 1062 undulatus (Bacillus), 716, 762 ungulata (Treponema), 1076 uniforme (Bacterium), 653 uniformis (Bacteroides), 572, 573, 576 unsformis (Ristella), 572, 576 upcotter (Actinomyces), 961 upcottii (Streptomyces), 961 upsilon (Marmor), 1155, 1172, 1175 urbana (Salmonella), 530 ureae (Albococcus), 238, 266 ureae (Bacillus), 688, 742 ureae a (Bacillus), 729 ureae & (Bacıllus), 742 ureae > (Bacillus), 744 ureae II and III (Bacillus), 729 ureae (Bacterium), 689

ureae (Mercela), 237

ureae (Micrococcus), 237, 251, 252, 257, 260, 263, 264, 265, 266, 269, 272, 274, 275, 277, 279, 282 ureae (Planosarcina), 289 urcae (Plocamobacterium), 688 urcae (Pscudomonas), 91 ureae (Sarcina), 289, 290, 291, 293 ureae (Sporosarcina), 289 ureae (Staphylococcus), 238 ureac (Streptococcus), 237 ureac (Torula), 279 urcae (Urococcus), 238 ureae candidus (Staphylococcus), 282 ureae liquefactens (Micrococcus), 266 ureae liquefaciens (Staphylococcus), 266 urcae (non pyogenes) (Diplococcus), 315 urcae non puogenes (Staphylococcus), 282 ureas (non pyogenes) rugosus (Streptococcus), 313 ureae (non pyogenes) trifoliatus (Diplococcus), 344 .. . 229

urinae equi (Pediococcus), 250 urinae fertilis (Bacillus), 655 urinae flavus olearius (Microeoccus), 269 urinae liquefaciens (Bacillus), 660

urinae striatus (Bacillus), 663

urinae tenuis (Bacillus), 670 urinalbus (Micrococcus), 279 urinaria (Nocardia), 976 urinarius (Actinomyces), 976 Urobacillus, 8, 705, 729 urocephalum (Bacillus), 823 urocephalum (Bacterium), 823 urocephalum (Granulobacter), 822 urocephalum (Tyrothrix), 823 Urococcus, 235 uromutabile (Bacterium), 452 Urosarcina, 285 ursidae (Treponema), 1076 uruguac (Micrococcus), 279 usbekistanica (Spirochaeta), 1070 utiformica (Bacterium), 120 utiformica (Phytomonas), 120 utiformica (Pseudomonas), 120 utpadeli (Bacillus), 671 utriculosus (Micrococcus), 201 urae (Bucillus), 478 uvae (Bacterium), 478 urae (Erwinia), 478 uraeformis (Bacıllus), 757

caccinae (Coryncbacterium), 401, 406 raccinae (Micrococcus), 315 taccinae (Microsphaera), 315 raccinae (Spirochaete), 1074 raccinae (Streptococcus), 345 raccinae (Treponema), 1074 vaccinii (Chlorogenus), 1150 racellans (Microspira), 696, 1001 vaculatus (Bacillus), 757 cacualata (Microderma), 76 vacuolatus (Bucillus), 671 racuolatus (Bacterrum), 671 racuolosus (Bacillus), 715 radosa (Pseudomonas), 701 raginae (Bacillus), 362, 363, 401, 693 vaginae (Bacterrum), 693 vaginae (Plocamobacterium), 362, 403 raginalis (Bacıllus), 362, 363 raginalis (Coccus), 250 raginalis (Leptothriz), 366 vagualis (Leptotrichia), 366 raginalis (Spirochaeta), 1074

topinalis (Treponema), 1974 cacinalis longus (Racellus), 362 igoinglum (Thionema), 995 raginatus (Jodocaccus), 251, 679 tommicola (Herrellea) 595 tanus nacumante (Racterium), 647 taillard: (Bacterium), 689 talerianicum (Clastridium), 822 talertei (Bacternon), 450 valeries (Proteus), 450 talidus (Bacıllus), 757 valinos orana (Bacillus), 757 vallus (Charon), 1267 Vallorillus, 11, 763 ialiulae (Actinamyces), 922 valvulae (Nocardia), 922 ialiulae destruens bavis (Oospora), 922 valiularis (Actinomyces), 922

taltularis destruens boris (Streptothrix), 922 van tieghemi (Urococcus), 282 variabile (Bacterium), 42

curaonie (Bacterium), 42 intribule (Comma), 402 intribule (Comma), 402 intribulis (Actinomyces), 918, 974 tortobius (Bactlins), 573 variabilis (Bacteroides), 573, 577 variabilis (Capsularis), 573, 577 variabilis (Chailstera), 573, 577 variabilis (Kurthia), 613 variabilis (Kurthia), 613 variabilis (Lantabar), 466

tariabilis (Kurihia), 613
tariabilis (Leptotrichia), 366
tariabilis (Leptotrichia), 367
tariabilis (Myzobotrys), 1028, 1037
tariabilis (Rasmussenia), 367
tariabilis (Sarcina), 291, 294

ipriabilis lymphae taceinalis (Bacillus), 401 varians (Bacillus), 757

tarians lactis (Mserococcus), 250
varicellae (Briareus), 1233
taricellae (Strephococcus), 345
taricosum (Bacterium), 689
taricosus conjunctiva e (Bactelius), 659
taricosus conjunctiva e (Bacterium), 659

partenata (Sarcina), 294 tarteaata (Zuberella), 578 carrenatus (Bacellus), 578 extregative (Racterordes, 578) tarracaccus (Micrococcus), 250 varialse (Borreliots), 1231 sarralue (Micrococcus), 345 sarrolae (Streptococcus), 315 cartalae (Stronaulaulasma), 1231 tariolae ovinae (Micrococcus), 345 parantae-arinae (Strentaeaccus), 315 carrolae var hominis (Borreliota), 1232 pariasum (Bacterium), 689 varius (Bacteroides), 567, 579 varius (Spherophorus), 567, 579 eascularum (Bacıllus), 163 sascularum (Bactersum), 163 rascularum (Phytomonas), 163 Lass ularum (Pseudomonas), 163 vascularum (Xanthomonas), 163, 639 vossales (Ractersum), 553 vastans (Aureopenus), 1155 tastant (Marmor), 1155 vastans var agallige (Aureogenus), 1158 rastans var lethale (Aureogenus), 1156 vastans var vuloare (Aureogenus), 1185 seboda (Bacıllus), 532 reboda (Bactersum), 532 seboda (Salmonella), 532 tegetus (Bacillus), 671

tarteanta (Dialisterea), 21

Veilionelia, 29, 31, 33, 34, 302, 303 vejdovskii (Paraspirillum), 218 vejle (Salmonella), 523 vekanda (Bacillus), 451

vclanda (Bacterium), 451 tekanda (Enteroides), 451 vekanda (Escherichia), 451 telatum (Bacterium), 689

relains (Bacillus), 689 relenosum (Bactersum), 553 selax (Bacillus), 671 teluina (Sarcina), 291

tendrelli (Bacilius), 701 tendrelli (Pseudomonas), 701 veneniferum (Marmor), 1191

tenenosum (Achromobacter), 427

venenosus (Bacillus), 427, 671 venenosus (Bacterium), 671 venenosus brevis (Bacillus), 671 venesosus brevis (Bacterium), 671 venenosus invisibilis (Bacillus), 671 venenosus invisibilis (Baclerium), 671 venenosus liquefaciens (Bacillus), 671 veneris (Cristispira), 1057 venetacnia (Murialba), 1172 veneziana (Salmonella), 526 venezuelensis (Borrelia), 1064 venezuelensis (Neisseria), 301 venezuelensis (Spirochaeta), 1064 venezuelensis (Treponema), 1064 ventricosus (Bacillus), 671, 753 ventriculi (Bacillus), 671 ventriculi (Merismopedia), 256 ventriculi (Planomerista), 284 ventriculi (Sarcina), 286, 291 ventriculi (Zymosarcina), 286 ventriculosus (Bacillus), 818 ventriculosus (Clostridium), 818 tentriculus (Bacillus), 753 ventriosus (Bacillus), 353 ventriosus (Bacteroides), 353 venturelli (Bacillus), 801 venturelli (Endosporus), 804 venturellii (Clostridium), 804 vermiculare (Bacterium), 718 vermicularis (Bacillus), 718 vermicularis (Sarcina), 294 vermiculosus (Bacillus), 671 vermiculosus (Bacterium), 671 vermiforme (Bacterium), 362 vermiforme (Belabacterium), 362, 830 vermiformis (Bacillus), 362 vermiformis (Sarcina), 234 vermiformis (Streptococcus), 345 verne (Actinomyces), 936 verne (Streptomyces), 936 rerneti (Gaffva), 284 vernicosum (Bacterium), 689 vernicosus (Bacillus), 753, 689 verrucae (Galla), 1158 verrucae (Molitor), 1241 verrucae vulgaris (Bacıllus), 684 verrucosa (Streptothrix), 924

Verrucosus, 763 verticillatum (Bacterium), 758 verticillatus (Bacillus), 753 resciculosa (Escherichia), 452 vescus (Bacteroides), 568 vescus (Fusiformis), 508 vesicae (Bacıllus), 758 resicae (Micrococcus), 280 vesicans (Micrococcus), 280 vesicatoria (Phytomonas), 163 vesícatoria (Pseudomonas), 163, 740 vesicatoria (Xanthomogas), 160, 163, 164, 1134 vesicatoria var. raphani (Bacterium), 164 resicatoria var. raphani (Phytomonas), 164 vesicatoria var. raphani (Xanthomonas),

vesicatorium (Bacterium), 145, 163

vesicosus (Micrococcus), 280 vesiculiferus (Bacillus), 671

vesiculiferus (Micrococcus), 280

resiculiformans (Bacillus), 451

vespertilionis (Spirillum), 1070

ecspertilionia (Spirochaeta), 1070

respertitionis (Spironema), 1070

vesperuginis (Spi ochaela), 1070

vesperuginis (Soconema), 1070

vialis (Bacillus), 671

viator (Bacellus), 671

192, 216, 763 vibrioides (Caulobacter), 832

mbrans (Ascococcus), 250

vespertilionis (Spi-aschaudinnia), 1070

Vibrio, 5, 7, 15, 18, 21, 25, 28, 29, 31, 33,

resiculosus (Bacillus), 452

vesiculiformans (Escherichia), 452

vesiculosum (Bacterium), 452, 689

verrucosaas (Ruga), 1219

verrucosum (Bacterium), 762

eshrion (Revolutiva), 275 Vebriotheir, 218 reburns (Ractersum) 134 mburni (Photomonas), 134 withproj (Pseudomonas) 134 menge (Racterium), 136 viciae (Phytomonas), 136 viciae (Pseudomonas), 136 sange (Raetersum), 119 viense (Marmor), 1188 signas (Phytomonas), 119 sanne (Pesudamonas), 119 vionae var leguminophila (Phytomonas). 120 esonals (Bactersum), 440 conobs (Racellus), 440 menicola (Xanthomonas), 703 villosum (Bacterium), 689 villosum (Plocamobacterium), 689 villosus (Bacillus), 671, 672, 689, 758 concents (Fussformss) 581 mincents (Helsconema), 1064 uncents (Spirochaeta), 1063 vincenti (Spironema), 1063 mncenti (Spiroschaudinnia), 1063 cincenti (Treponema), 1063 encents var. bronchialia (Spirochaeta). vincentii (Borrelia), 1063, 1068, 1069, 1070 vincenzu (Mucrococcus), 280 einelandis (Azolobacter), 219, 220 uns (Micrococcus), 280 mns (Strentacoccus), 345 vini acetati (Bacterium), 188 vinicola (Bacillus), 672 rinicola (Baeterium), 689 riniperda (Bacillus), 672 viniperda (Bacterium), 689 viniperda (Micrococcus), 280 rinosa (Monasi, 858 einosum (Bacterium), 858 vincsum (Chromatium), 858, 859 cinosus (Bacillus), 853 esolacea (Cladothrix), 974 violacea (Lampropedia), 844 violacea (Merismopedia), 250, 844

riolacea (Nocardia), 974

violacea (Oospora), 974 siolness (Planasarcina), 847 proloces (Pseudomonas), 7, 231 violacea (Streptotrix), 974 violaces (Thiocystis), 847 violaceoniger (Streptomyces), 947 moloreum (Aomenellum) R14 moloceum (Racteridium), 231 ciolaceum (Racterium), 231, 233 violaceum (Chromatium), 858, 859 violaceum (Chromobacterium) 231, 234 molaceum (Cromobacterrum) 231 molaceum (Smrillum), 852 violoceum (Throsphaerran), 859 violaccum (Thiospirillum), 852, 859 explaceum amelhustinum (Bacterium) 232 violaceum laurentium (Chromobaeterium) stolaceum lutetsense (Chromobactersum) 223 violaceum manilac (Chromobacterium). 232, 234 violaceus (Actinomyces), 935, 974 violaceus (Bacillus), 231, 233, 758 detare . in violaceus laurentius (Bacterium), 233 emuceus sartory: (Hacillus), 233 tiolarius (Aerobacillus), 720

stoqueus Bartorys (Hacillus), 233
stolarius (Aerobactilus), 720
stolarius actionicus (Bacillus), 720
strchou (Salmonella), 511
strchouris (Sarcana), 233
strens (Bacillus), 672
stretens (Bacillus), 672
stretens (Bacillus), 619

virescens (Bacterium), 701 virescens (Myxococcus), 1006, 1007, 1008, 1042

virescens (Pseudomonas), 149, 701 virgatum (Marmor), 1202 virgatum var. typicum (Marmor), 1202

virgatum var. viride (Marmor), 1202 virgatus (Bacillus), 718 virginia (Salmonella), 515

virginianum (Spirillum), 214

Virgula, 32

virgula (Bacterium), 762 virgula (Tyrothrix), 762

viridans (Bacillas), 149, 672

viridans (Pseudomonas), 149 uridans (Streptococcus), 321

viridans (Vibrio), 703

viride (Bacterium), 689, 762 viridescens (Pseudomonas), 150

viridescens liquefacions (Bacillus), 150

viridescens non-liquefaciens (Bacillus), viridescens non-liquefaciens (Bacterium),

viridifaciens (Bacterium), 119 viridifaciens (Phytomonas), 119 rırıdıfaciens (Pseudomonas), 119 viridiflava (Phytomonas), 127 viridiflava (Pseudomonas), 127 viridiflava var. concentrica (Phytomonas),

127 viridiflava var. concentrica (Pseudo-

monas), 127 viridi-flavescens (Staphylococcus), 261. viridiflavum (Bacterium), 127

concentricum (Bacviridislavum var terium), 127 viridi-glaucescens (Bacillus), 758

viridilivida (Phytomonas), 114 viridilivida (Pseudomonas), 114 viridilividum (Bacterium), 114 viridi-luteus (Bacillus), 693, 758

viridis (Actinomyces), 974 viridis (Bacillus), 660, 762

viridis (Bacterium), 660 viridis (Cellfalcicula), 211

viridis (Micrococcus), 261

wiri Pr // .... 11. 1 ...

viridis flaicscens (Sarcina), 201 viridis flavescens (Staphylococcus), 261 viridis pallescens (Bacillus), 149 virides pallescens (Bacterium), 693 viridochromogenes (Actinomyces), 942 viridochromogenes (Streptomyces), 942 viridulum (Bacterium), 736

viridulus (Bacillus), 736 virosum (Chromatium), 855 viscidum (Bacterium), 689 viscifaciens (Clostridium), 774

visco-coccoidium (Baclerium), 414 viscofucatum (Bacterium), 234 viscofucatum (Chromobacterium), 234 viscofucatus (Bacıllus), 234

viscogenum (Lactobacterium), 304 viscosa (Eberthella), 541 viscosa (Pseudomonas), 90, 97, 701

viscosa (Shigella), 511 viscosum (Acetobacter), 188 riscosum (Achromobacter), 414

viscosum (Agarbacterium), 629 viscosum (Bacterium), 414, 680, 683, 689, 701, 760, 788

viscosum (Chromobacterium), 234 viscosum (Clostridium), 822 viseosum (Plocamobacterium), 692

viscosum equi (Bacterium), 540 viscosum non-liquefaciens (Bacterium),

viscosus (Alcaligenes), 414, 692 riscosus (Bacillus), 90, 689, 758 viscosus No. 1 (Bacillus), 680

viscosus (Bacteroides), 577 viscosus (Diplococcus), 271 viscosus (Lactobacillus), 411

viscosus (Micrococcus), 280, 340 viscosus (Staphylococcus), 701

viscosus (Streptococcus), 345 viscosus var. dissimilis (Alcaligenes), 414 viscosus bruxellensis (Bacillus), 758 uscosus cercvistae (Bacillus), 680

viscosus cerevisiae (Bacterium), 680 riscosus Inctis (Bacillus), 414 viscosus lactis (Bacterium), 414 viscosus lactis (Micrococcus), 280 viscosus margarineus (Bacillus), 689 viscosus ochraceus (Bacillus), 761 viscosus sacchari (Bacillus), 689 viscosus rini (Bacillus), 689 visco-symbioticum (Achromobacter), 427 11sco-symbioticum (Bacillus) 427 usicidus (Micrococcus), 696 pitalis (Bacillus), 710 utarumen (Flavobacterium), 613 vitellinum (Polyangium), 1026, 1030 vitians (Bacterium), 153 vitians (Phytomonas), 153 vitians (Pseudomonas), 153 vitians (Xanthomonas), 153 vitiala (Phytomonas), 640 uticola (Bacillus), 758 viticola (Marmor), 1198 uticulosus (Micrococcus), 280 11tis (Bacillus), 639, 759 vitavora (Erwania), 466, 478 ultvorus (Bacillus), 460 vitres (Hydrogenomonas), 77, 78 ulreum (Azotobacter), 220 vitreus (Bacillus), 758 vitulae (Tarpett), 1272 vitulinum (Bacterium), 059 vitulisepticit (Pasteurella), 518 titulisepticum (Eacterium), 548 vitulisepticus (Bacillus), 548 vitulorum (Bacterium), 689 itulorum (Streptococcus), 313 tivax (Spirochaeta), 1054 tuax (Trepourma), 1054 Styerrae (Tarpera), 1273 togein (Bacillus), 75% toldagsen (Bactilus), 510 tolubilis (Leptothinz), 986 volutans (Achromatium), 995, 999 volutana (Spirillum), 216, 217 colutions (Throph, sq.), 998, 979 tolulans (Thioporphyra), 859 voukn (Thiothrix), 990

cuillemins (Baeillus), 6113

culaare (Bacterium), 486 sulvare (Caseobactersum), 356 sulgare (Hyphomicrobium), 837 vulgaris (Bacillus), 457 vulgaris (Cellvibrio), 210 vulgaris (Micrococcus), 281 vulgaris (Micromonospora), 980 vulgaris (Proteus), 486, 487, 490, 491, 672 vulgaris (Pulribacillus), 799 sulgaris (Siderocystis), 835 rulgaris (Streptococcus), 345 vulgaris (Thermoaclingmuces), 980 vulgaris (Theimobacillus), 733 vulgaris (Bacterium) (Proteus), 487 vulgata (Pasteurella), 570 sulgatus (Bacillus), 709, 711, 743, 745, 747, 748, 762 vulgatus (Bacteroides), 569, 572, 577 tulpinus (Bacillus), 672 value (Tarpera), 1273 uakefield (Bacterium), 543

uaksmannıı (Actinomyces), 935 wallemia (Streptothrix), 977 uardii (Bacillus), 672 narningii (Chromatium), 857, 859 uarmingii (Monas), 857 warmingst forma minus (Chromatium), 857, 858 uashingtonia (Phylomonas), 697 ugtareka (Bacillus), 532 untarcka (Bacterium), 532 natareka (Salmonella), 532 uatemannte (Barrlins), 758 neckeri (Bacillus), 672 uedmoreusis (Actinomyces), 974 uceksi (Bacillus), 589 uehmeri (Bacillus), 359 nehmeri (Lactabacıllus), 359 uethelii (Microspira), 202, 206 weichselbaumis (Bacillus), 655 ucichselbaumii (Neisseria), 296, 297 ucickselbaumii (Streptococcus), 297 weigh (Rickettsia), 1007, 1098 uciamanni (Aremabacillus), 736 weigmanni (Bacillus), 758, 782 weigmanni (Pseudomonas), 150

Weinbergillus, 11, 763 weisii (Chromatium), 857 weissei (Chromatium), 856, 857, 853 weissii (Bacillus), 857 weissii (Bacterium), 857 weissii (Chromatium), 857 wcissii (Streptoeoccus), 345 Welchia, 20, 22, 33, 34, 763 welchis (Racillus), 62, 369, 790 welchii (Bacterium), 790 welchii (Clostridium), 43, 369, 790 welchii (Typo agni) (Clostridium), 790 welchis Type A (Bacillus), 700 welchii Type B (Bacillus), 790 welchis Type C (Bacsillus), 790 welchii Type D (Bacillus), 700 Welchillus, 11, 23, 27, 763 welckeri (Sareina), 201 welckeri (Merismopedia), 291 wellevreden (Salmonella), 521 wenyous (Bartonella), 1112, 1113 wenyoni (Eperythrozoon), 1112, 1113 wennons (Haemobartonella), 1113 werahensis (Bacillus), 532 werahensis (Salmonella), 532 werneri (Clostridium), 808 wesenberg (Racillus), 531, 672 tresenbergs (Eberthella), 534 wesenbergi (Wesenbergus), 531 115 All at 2"9

Wesenbergus, 10, 516
whitmori (Bacillus), 555, 556
whitmori (Loefferella), 556
whitmori (Sclerothrix), 555
wichita (Solmonella), 527
wieringae (Bacterium), 672
wieringae (Bacterium), 672
wieringae (Phytomonas), 144
wintingae (Phytomonas), 144
wintingae (Pseudomonas), 144
wintleri (Bacillus), 693
winkleri (Bacillus), 693
winkleri (Keisseria), 253
arilegoda (Bacillus), 533
willegoda (Salmonella), 533
willegoda (Salmonella), 533
willegoda (Salmonella), 566

willmorei (Streptomyces), 966 wilsonsi (Eberthella), 534 winogradskii (Leptothrix), 986 winogradskii (Thiospirillum), 853 winogradskyi (Bacillus), 772 winogradskyi (Nitrobacter), 74 winogradskyi (Sulfospirillum), 212 winogradskyi (Thiospira), 212 winogradskyi (Thiospirillum), 212 wirthis (Spherocillus), 580 Wolbachia, 1008 wolfii (Microspira), 198 wolfii (Vibrio), 198 wolf-israel (Actinomyces), 927 wolhynica (Riekettsia), 1004 woliniae (Bacillus), 533 woliniae (Baclerium), 533 woliniae (Salmonella), 533 woodsii (Bacterium), 143 woodsii (Phylomonas), 143 woodsii (Pscudomonas), 143 woodstownii (Azotobacter), 219 worthington (Salmonella), 527 wortmanni (Plocomobacterium), 633 wortmannsi (Bacillus), 356, 693 wortmannii (Lactobacillus), 356 urightii (Bacterium), 689

ranthochrus (Paeudomonas), 101
ranthogenes (Bacterium), 700
ranthogenes (Tibrio), 700
ranthogenicus (Cryptococcus), 281
ranthogenicus (Gryptococcus), 281
ranthogenicus (Micrococcus), 281
ranthogenium (Clustridium), 822
Kanthomonas, 160, 171, 178
ranthostromus (Actinomyces), 974
ranthus (Myvococcus), 1007, 1008, 1042
ranpa (Eberthélia), 531
renopus (Micrococcus), 281
renopus (Micrococcus), 281
renophilus (Micrococcus), 281

-1 177

Mycol, Soc., 26, 1943, 10.) From Gr. panax (panicis), a plant heal-all. M. L. Panaz, a peneric name

Description from Elliott, Bact Plant

Pathogens, 1930, 173,

Rods: 0 5 by 1 3 to 1.5 mierons Chains. Motile with 4 to 6 polar flarella. Gromnecative

Green fluorescent pigment produced in culture.

Gelatin: Shaht liquefaction

Agar colonies: White

Milk: Cosmilated.

No cas from sugars.

Habitat: Causes a root rot of ginseng, Panax quinquefolium.

111. Pseudomonas aleuritidis (McCulloch and Demarco) Stapp (Bacterium aleuritidis McCulloch and Demarce. Jour. Agr. Res., 45, 1932, 339, Stann. Bot. Rev., 1, 1935, 408; Phytomonas alcuritidis Magrou, in Handurov et al . Diet d. Bact. Path., Paris, 1937, 328) From Gr. alcurites, of wheaten flour, M. L. Aleurites, generic name.

Rods: 06 to 07 by 1.1 to 3 microns. Motile with 1 to 5 polar, rarely bipolar, flagella. Capsules present. Gram-nega-

tice.

Green fluorescent pigment produced in certain media.

Gelatin · Not liquefied.

Beef agar slants: Growth is thin, white and viscid.

Broth: A heavy white surface growth

in 21 hours. Sediment. Milk: Becomes alkaline, but no sep-

aration.

Nitrites are produced from nitrates

Indole test feebly positive flydrogen sulfide test feebly poutive

Acid but no gas from glucose, galactose and glycerol. Slow acid production from sucrose, maltose and lactore

Starch hydrolysis feeble. Optimum temperature 27° to 25°C.

Maximum temperature 37°C. Optimum pH 6.2 to 6.8 pH range 54

to S 9.

Source. Isolations from naturally infected tune oil trees in Georgia.

Habitat. Pathogenic on the tung oil tree (Aleurites fordi), on the bean (Phasealus vulgaris) and the easter bean (Ricinus communis)

112. Pseudomonas glycinea Coerner. (Bacterium alucineum Coerper, Jour. Agrie. Research, 18, 1919, 188; Cocrper, loc. cut. 188: Phytomonas alucinea Burkholder, Phytopath., 18, 1926, 922) From alucus, sweet; inc. like: M.L. Glucine, generic name.

Synonym: Bacterium soige Wolf, Phytopath . 10, 1920, 132 (Phylomonas sojae Burkholder, Phytopath . 16, 1926, 922; Pseudomonas sojae Stapp, in Sorauer. Handb d. Pflanzenkrankheiten, 2, 5 Auff., 1928, 174), Sec Elbott, Bact. Plant Pathogens, 1030, 134; and Shunk and Wolf, Phytopath., 11, 1921, 18.

Rods: 12 to 1.5 by 23 to 3 microns. Motile with polar flagella. Gram-nega-

tive.

Green fluorescent pigment produced in cufture.

Gelatin: Not liquefied.

Beef-peptone agar colonies: Appear in 24 hours. Circular, creamy white, smooth, shining and convex. Margins entire. Butyrous in consistency.

Milk. Litmus turns blue and later a separation of the rollk occurs. Casein not

directed.

Nitrites not produced from nitrates

Indole test feebly positive.

Not inpolytic (Starr and Burkholder, Phytopath , 32, 1912, 601). Starch not hydrolyzed.

Acid from glucose and sucrose Optimum temperature 21° to 26°C.

Maximum 35°C. Minimum 2 C Lacultative anaerobe.

Source: A number of cultures isolated from soy beans in Wisconsin.

Habitat: Pathogenic on goybean, Glyeine max (Soja max).

Pseudomonas glucinea var 1124. saponica (Takimoto) comb. nor (Barzerosis (Bacıllus), 386 xerosis (Baclerium), 386 zerosis canis (Bacillus), 406 rerosis canis (Corynebacterium), 406 xerosis variolae (Bacillus), 401 zulanicus (Bacıllus), 758 xylina (Ulvina), 692 vylinoides (Bacterium), 187, 693 xylinoides (Ulvina), 603 xylinum (Actobacter), 181, 182, 187, 692 xylinum (Bacterium), 181, 187 xylinus (Bacıllus), 692 zvlitica (Vibrio), 207 xylophagus (Bacrillus), 758 xylosus (Lactobacillus), 363 vasakı: (Vibrio), 702 yersini (Coccobacillus), 549 Yersinia, 550, 703 zagreb (Salmonella), 504 zanzibar (Salmonella), 524 Zaogalacima, 479 zeae (Bacıllus), 457 zeae (Bacterium), 457 zeae (Butylobacter), 781, 825 zeae (Fractilinea), 1161 zeae (Galla), 1158 zeae (Marmor), 1161 zene (Micrococcus), 281 zene (Prontonibacterium), 375, 377 zeidleri (Acetobacter), 185 zeidleri (Bacillus), 185 zeidleri (Bacterium), 185 zenkers (Bacillus), 608 zenkeri (Bacterium), 608 zenkeri (Kurthia), 603 zenkeri (Proteus), 608 zenkeri (Zophus), 608 zeta (Bacillus), 672 zeta (Bacterium), 672 Zetinowia, 12, 13, 604 zettnouis (Flacobactersum), 173 zeylanicum (Spirillum), 218

zeylanıcum (l'ibriothrix), 218

zeylanicus (Bacıllus), 218

verose (Corynebacterium), 386, 401

zeylanicus (Spirobacillus), 218 zeylanicus (Vibrio), 218 zingiberi (Bacterium), 171 zingiberi (Phytomonas), 171 zingiberi (Pseudomonas), 171 zingiberi (Xanthomonas), 171 zinnioides (Bacterium), 690 zırnıı (Bacıllus), 758 zlatogorovi (Spirochaeta), 1070 zonatus (Anaulus), 1212, 1213, 1214, 1217 zonatus (Bacilius), 672 zonatus (Micrococcus), 281 zoodysenteriae (Bacıllus), 701 zoodysentersae hungaricus (Bacillus), 701, zooepidemicus (Streptococcus), 316 zoogleicum (Clostridium), 797 200glesformans (Bacterium), 577 toogleiformans (Capsularis), 577 Zoogloea, 318 20pfi (Helikobacterium), 608 zopfi (Streptothrix), 977 Zopfiella, 705 20pfix (Bacellus), 603 zopfu (Bacterium), 608 20pfis (Kurthsa), 608 zopfie (Zopfius), 608 zopfii (Bactersum) (Proteus), 608 Zopfius, 42, 603 zörkendörfers (Bacillus), 672 zörkendörfers (Pseudomonas), 150 Zuberella, 33, 34, 577 zuernianum (Bacterium), 690 zuernianus (Bacillus), 690 zuntzıs (Clostridium), 822 Zygopłagia, 12, 13, Zygostasıs, 12, 13, 705 Zymobacıllus, 30, 705 zymogenes (Coccobacillus), 672 zymogenes (Micrococcus), 327 zymogenes (Staphylococcus), 327 zymogenes (Streptococcus), 327 Zymomanas, 29, 30 Zymosarcina, 29, 30, 31, 285 zymoseus (Bacillus), 672 zythi (Streptococcus), 315

verose (Corynebacterium), 386, 401 xerosis (Bacıllus), 386 zerosis (Bacterium), 386 xerosis canis (Bacillus), 406 zerosis canis (Corynebacterium), 406 xerosis variolae (Bacillus), 401 xylanicus (Bacıllus), 758 xylina (Ulvina), 692 cylinoides (Bacterium), 187, 693 xylmoides (Ulvina), 693 xylinum (Actobacter), 181, 182, 187, 692 xylınum (Bacterium), ISI, IS7 zylinus (Bacıllus), 692 xylitica (Vibrio), 207 xylophagus (Bacıllus), 758 zylosus (Lactobacillus), 363

yasakıı (Vibria), 702 yersini (Coccobacillus), 549 Yersinia, 550, 703

zagreb (Salmonella), 504 sanzibar (Salmonella), 524 Zaogalactina, 479 zeae (Bacıllus), 457 seae (Bacterium), 457 seas (Butylobacier), 781, 825 zeac (Fractilinea), 1161 zeae (Galla), 1158 zene (Marmor), 1161 zeae (Micrococcus), 281 zese (Propionibacterium), 375, 377 zeidleri (Acetobacter), 185 zeidleri (Bacillus), 185 zeidlers (Bactersum), 185 zenkers (Bacsilus), 608 zenkeri (Bacterium), 608 zenkers (Kurthia), 608 zenker: (Proteus), 608 zenkers (Zopfius), 608 zela (Bacıllus), 672 zeta (Bactersum), 672 Zeiinowia, 12, 13, 604 zetinous (Flarobaciersum), 173 zeylanıcum (Spirillum), 213 reylanicum (Vibriothrix), 21% zeylanicus (Bacıllus), 218

zeylanicus (Spirobacillus), 218 zeylanicus (Vibrio), 218 zingiberi (Bacterium), 171 zıngıberi (Phytomonas), 171 zingiberi (Pseudomonas), 171 zingiberi (Xanthomonas), 171 zinntoides (Bacterium), 690 zırnıı (Bacıllus), 758 zlatogorom (Spirochaeta), 1070 zonatus (Annulus), 1212, 1213, 1214, 1217 zonatus (Bacıllus), 672 zonatus (Micrococcus), 281 zoodysenteriae (Bacıllus), 791 zoodysenteriae hungaricus (Bacillus), 791, zooepidemicus (Streptococcus), 316 zoogleicum (Clostridium), 797 zooglesformans (Bacterium), 577 200gletjormans (Capsularis), 577 Zoogloea, 348 zopfi (Helikobacterium), 608 20pfi (Streptothriz), 977 Zopfiella, 705 zopfit (Bacillus), 608 zopfu (Bacterium), 608 20pfit (Kurthia), 608 zopfie (Zopfius), 608 zopfii (Bactersum) (Proteus), 608 Zopfius, 42, 608 zörkendörfert (Bacılluz), 672 zörkendörfers (Pseudomonas), 150 Zuberella, 33, 34, 577 zuernianum (Bacterium), 690 zuermanus (Bacilius), 690 zuntzıs (Clostridium), 822 Zygoplagia, 12, 13, Zygostasıs, 12, 13, 705 Zymobacıllus, 30, 705 zymogenes (Coccobacillus), 672 zymogenez (Micrococcus), 327 zymogenes (Staphylococcus), 327 zymogenes (Streptococcus), 327 Zymomonas, 29, 30 Zymosarcina, 29, 30, 31, 285 zymoseus (Bacillus), 672

zythi (Streptococcus), 345

terum soyae var. japonicum Takimoto, Jour. Plant Protect. Tokyo, 14, 1927, 556; Bacterium glycineum var. japonicum Elliott, Bact Plant Pathogens, 1930, 136; Phytomonas glycinea var. japonica Magrou, in Hauduroy et al., Diet d. Bact. Path., Paris, 1937, 358.) From M. L. Japonicus, inpanese

Distinctive characters Differs slightly from Pseudomonas glycinea in size of cell, length of chains, action in milk, and color in media Okabe (Jour. Soc. Trop. Agr., Formosa, 6, 1033, 162) gives a description of the organism which leads one to believe the differences are not great concell to be varietal.

Source. Isolated from leaf spots on soy bean in Formosa.

Habitat. Pathogenic on soy bean, Glycine max.

113. Pseudomonas savastanol (Erw. Smith) Stevens (Bacterium saeastanoi Erw Smith, U S. Dept. Agr Plant Ind. Bull 131, 1903, 31; Stevens, The Fungi which Cause Plant Diseases, 1913, 33; Phytomonas sarastanoi Bergey et al, Manual, 1st ed , 1923, 190.) Named for F. Savastano, the Italian plant pathologist.

Nore Smith (loc cit.) lists and discards the following species since they were either mixed cultures or names with no descriptions. Bacterium oleae Arcangeli, 1stit. Bot. delle R. Univ. di. Pisz, Riscrelle e Lavori, fase 1, 1886, 109, Bacilus oleae tuberculosis Savastano, Atti R. Accad Naz Lincei Rend. Cl. Sci. Fis., Mat. e Nat. 6, 1889, 92; Bacillus prilleuzzanis Trevisan, I generi e le specie delle Batteriacee, Milano, 1889, 19; Bacillus oleae De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 982.

Description from Brown, Jour. Agr Res , 44, 1932, 711.

Rods 04 to 08 by 12 to 33 microns Motile with 1 to 4 polar flagella. Cramnegative

Green fluorescent pigment found in culture

Gelatin: No liquefaction.

Beef ngar colonies: White, smooth, flat, glistening, margins erose or entire. Broth: Turbid on the second day. No pellicle or ring.

Milk: Becomes alkaline.

Nitrites not produced from nitrates. No H<sub>2</sub>S produced.

Acid but not gas from glucose, galactose and sucrose.

Starch is hydrolyzed

Optimum temperature 23° to 24°C. Maximum 32°C. Minimum 1°C.

Optimum pH 6.8 to 7.0. Maximum 8.5. Minimum 5 6.

Aerobic.

Source: Smith isolated his cultures from olive galls collected in California. Habitat: Pathogenie on olive.

113a. Pseudomonas savastanoi var. frazini (Brown) Dowson. (Bacterium savastanoi var. frazini Brown, Jour. Agr. Res., 44, 1032, 721; Phytomonas sarastanoi var. frazini Magrou, in Hauduroy et al. Diet d. Bact. Path., Paris, 1037, 410; Pseudomonas frazini Skorie, Ann Exp. For. Zagreb, 6, 1083, 66; Dowson, Trans. Brit. Mycol. Soc., 26, 1943, 11.) From M. L. Frazinus, a genetic

name.
Distinctive characters: Differs but slightly from Pseudomonas savastanoi, but is pathogenic on ash and not on olive-

Source: Three cultures isolated from cankers on ash.

Habitat: Pathogenie on ash, Frazinus excelsior and F. americana.

114. Pseudomonas tonelliana (Ferraria) comb. nov. (Bacterium tonellianum Ferraria, Trattato di Patologia e Terapia Vegetale, 3rd ed., I, 1926, 104; Phytomonas tonelliana Adams and Pugsley, Jour. Dept. Agr. Victoria, 52, 1934, 304.) Named for Tonelli, the Italian botanist.

Synonym: Pseudomonas savastanos var. neru C. O Smith, Phytopath., 18, 1923, 503.

Description from Smith (loc. cit.) unless otherwise noted.

Rods: 0.5 to 0 6 by 1 5 to 2.5 microns Motile with 1 to 3 polar flagella. Gramnegative (Adams and Pugsley, loc. cit ).

Gelatin: No liquefaction.

Potato glucose agar colomes: Flat, circular, shining, margins somewhat undulated.

Broth Dense clouding with partial

pellicle. Milk: Alkaline. No separation

Nitrites not produced from nitrates (Adams and Pugsley). Indole produced. Not produced (Adams

and Pugsley). Acid but not gas from glucose and

sucrose. No acid from lactose (Adams and Pugsley).

Starch not hydrolyzed (Adams and Pugsley),

Distinctive character: Pseudomonas satastanoi is similar in culture but is not pathogenic on oleanders.

Source: Both Ferraris and C O. Smith isolated the nathogen from galls on oleander.

Habitat : Pathogenic on oleander, Nersum oleander.

115. Pseudomonas calendulae (Takimoto) Donson. (Bactersum calendulae Takimoto, Ann. Phytopath Soc Japan, 5, 1936, 311: Phytomonas calendulae Burkholder, in Manual, 5th ed., 1939, 201; Dowson, Trans. Brit Mycol. Soc. 26, 1943, 9.) From Latin, calendae, throughout the month; M L. Calendula, a generic name.

Rods: 0.5 by 1 to 2 microns with I to 3 polar flagella Gram-negs-

Green fluorescent pigment produced in Uschinsky's and in Cohn's solutions

Gelatin: Not hauefied. Agar colonies: Circular, smooth, flat,

dirty white. Broth: Turbid.

Milk: No congulation

Nitrates not produced from nitrates Indole formed in small amount.

No Il S produced.

Acid but not gas from glucose and glycerol. No neid from lactose or sucrose.

Starch not hydrolyzed Optimum temperature 27° to 30°C.

Maximum 37°C. Minimum 0° to 7°C.

Habitat. Pathogenic on marigolds. Calendula officinalis.

116 Pseudomonas cichorli (Swingle) Stapp. (Phytomonas cichorui Swingle. Phytopath , 15, 1925, 730; Stapp, in Sorauer, Handbuch der Pflanzenkrankheiten. 2, 5 Auf., 1928, 291; Bacterium cichorii Elliott, Baet. Plant Pathogens, 1930, 112 ) From Gr cichoria, chicory: M. L Cichorium, generie name.

Probable synonyms · Pseudomonas endiriac Kotte, Phyt. Ztschr , 1, 1930, 609; Phytomonas endivide (Kotte) Chra. Cornell Agr. Exp Sta Mem 159, 1934, 26; and Bacterium formosanum Okabe, Jour Soc. Trop. Agr., Pormosa, 7, 1935. 65

Description from Clara (loc cit.) which is a description of a culture of Pseudomonas endiciae from Kotte. Swingle's description is very meager.

Rods 075 to 15 by 15 to 375 microns. Motile with 1 or 2 polar flagella. Gramnegative.

Green fluorescent pigment produced in culture.

Gelatin: No liquefaction.

Beef-extract agar colonies, Circular, gravish-white with blush tinge, raised with elightly irregular edges.

Broth Turbid in 36 hours with a smooth viscous pelhele.

Milk Alkaline

Nitrites not produced from nitrates. Indole not formed.

No ILS formed.

Not lipolytic (Starr and Burkholder, Phytopath , 52, 1912, 601).

Acid but not gas from glucose, galactose, fructose, manuose, arabinose, xylose, mannitol and glycerol. production from salts of acetic, citric. lactic, make, ruccinic and tartaric acids. Rhamuose, maltose, sucrose, lactose, raffinose and salicin not utilized.

Starch not hydrolyzed. Slight growth in broth plus 6 per cent

Optimum pH 6.8 to 7.1. Maximum

9.2 to 9.4. Minimum 5.0 to 5.3 (Kotte. Phyt. Ztsch., 2, 1930, 453).

Facultative anaerobe.

Distinctive characters: Differs from Pseudomonas intybi in that it does not liquefy gelatin or reduce nitrates to nitrites.

Source: Isolated from rot of French endive, Cichorium intybus by Swingle and by Okabe, and from C. endwia by Kotte.

Hahitat: Pathogenic on endive, lettuce and larkspur.

117. Pseudomonas cissicola (Takimoto) comb. nov. (Aplanobacter cissicola Takimoto, Ann. Phytopath. Soc. Japan .. 9, 1939, 43.) From Greek, cissus, ivy;

M. L. Cissus a generic name. Rods · 0.5 to 0.9 by 1 0 to 2 0 microns. Non-motile. Capsules. Gram-negative.

Green fluorescent pigment formed in Uschinsky's solution.

Gelatin: No liquefaction.

Potato-extract agar colonies: Circular. convex, smooth, and dirty white.

Broth: Feeble clouding followed by precipitation of pelliele and rim.

Nitrites not produced from nitrates. Indole not formed.

Hydrogen sulfide not produced.

No acid nor gas from sucrose, glucose, lactose and glycerol.

Starch is not digested.

Salt toleration is 3 per cent.

Optimum temperature 30°C. Maximum 35°C. Minimum 10°C. Thermal death point 49° to 50°C.

Source: Isolated from black spots on leaves of Japanese ivy, Cissus japanica in

Habitat. Pathogenic only on Cissus japonica

118. Pseudomonas nectarophila (Doidge) Rosen and Bleeker. (Bacterium nectarophila Doidge, Ann. Appl. Biol., 4, 1917, 73; Phytomonas nectarophila Bergey et al., Manual, 3rd ed., 1930, 262; Rosen and Bleeker, Jour. Agr. Res., 46, 1933, 93.) From Gr. nector. nectar; philus, loving,

Rods: 0.5 to 0.7 by 0.6 to 1.5 microns. Motile with 1 to 5 polar flagella. Capsules. Gram-negative.

Green fluorescent pigment produced in culture.

Gelatin: No liquefaction.

Nutrient agar colonies: Yellowishwhite, wet-shining, smooth, margins irregular.

Broth: Heavy turbidity in 24 bours. Sediment.

Milk: Cleared.

Nitrites not produced from nitrates. Indole not formed.

Acid from glucose and galactose. No acid from sucrose.

Starch by drolysis feeble.

Optimum temperature 25 to 30°C.

Facultative anaerobe.

Distinctive character: Differs from Pseudomonas barkeri in that it does not liquefy gelatin, nor produce indole. Produces capsules.

Source: Isolated from blighted pear blossoms in South Africa.

Habitat: Pathogenic on pear blossoms.

119. Pseudomonas viburni (Thornberry and Anderson) Stapp. (Phytomonas viburni Thornberry and Anderson, Phytopath., 21, 1931, 912; Stapp, Bot. Rev., 1, 1935, 407; Bacterium viburni Burgwitz, Phytopathogenic Bacteria, Leningrad, 1935, 160.) From L. viburnum, the wayfaring tree; M. L. Viburnum, a generic bame.

Rods: 05 to 1.0 by 1 to 2.0 microns. Capsules present. Motile with 2 to 4 polar flagella. Gram-negative (Burkbolder); not Gram-positive as stated.

Green fluorescent pigment produced in culture (Burkholder).

Gelatin: No liquefaction.

Glucose beef-extract colonies: Dull gray, circular, edges entire.

Broth: Turbid with pellicle. Milk: Alkaline.

Nitrites not produced from nitrotes

Indole not formed No 11-S formed.

Not lipolytic (Starr and Burkhelder, Phytopath., 52, 1942, 601)

Acid from glucose and galactose, but not sucrose (Burkholder).

Starch: No hydrolysis.

Slight growth in 3.5 per cent salt (Burkholder)

Ontimum temperature 25°C. Minimum 12°C. Maximum 35°C.

Acrobic

Source: Isolated from angular leaf spots and stem lesions on arrow-wood. Viburnum onulus, etc

Habitat: Pathogenic on Viburnum spp.

120. Pseudomonas mori (Boyer and Lambert) Stevens. (Bacterium mori Boyer and Larobert, Compt. rend. Acad Sci. Paris, 117, 1893, 342; Bactersum mor: Bover and Lambert emend. Drw Smith. Science, \$1, 1919, 792, Stevens, The Fung: which Cause Plant Diseases, 1913, 30, Bacillus mori Holland, Jour Bact, 5, 1920, 222: Phytomonas mori Bergey et al , Manual, 1st ed., 1923, 191.) Trom Cr. morum, mulberry; M. L. Morus, n cenerie name

Synonyma: Elliott (Bact, Plant Pathogens, 1930, 166) fists Bacillus cubonianus Macchiati, Staz. Sperim Agr Ital, 25, 1892, 228 (Macchiati described the disease due to Pseudomonas mors, but gave an incorrect description of the pathogen); also Bacterium cubonianum Ferraris, Curiano le Plante, 6, 1928, ISO (Perraris uses Macchiati's name but the description of Pseudomonas mort).

Description from Smith (loc. cit ) Rods: 09 to 1.3 by 1.8 to 4.5 microns.

Motile with a polar flagellum. Gramnegative Green fluorescent pigment produced in

culture. Gelatin: Not linuched

Agar colonies: White, slow growing, smooth, flat, edges entire becoming unMilk: Becomes alkaline and clears. Nitrites not produced from nitrates. Indole none or feeble production. Hydrogen sulfide not produced (Ol abo

Jour. Sec. Trop. Agr., 5, 1933, 166).

No growth in broth plus 4 per cent salt (Okahe loc cit )

No gas from carbohydrates.

Temperature tance 1°C to 35°C.

Source: Smith isolated the nathogen from blighted shoots of mulberry from Georgia. Also received cultures from Arkansas and the Pacific Coast.

Habitat: Pathozenic on roulberry. Marue.

 Pseudomonas stizolobii (Wolf) comb. nov. (Aplanobacter stizolobis Wolf. Phytopath., 10, 1920, 79; Bacterium stizolobri McCulloch, Phytopath , 18, 1928, 460: Phytomonas stizolobii Bergey et al., Manual, 3rd ed . 1930, 280.) From Gr. stize, to prich: lobium, a little lobe; Steelobium, a generic namo.

Rods: 0.6 to 0.7 by 1 0 to 1.6 microns. Non-mottle (Wolf). Mottle with a short polar flagellum (McCulloch). Capsules. Gram-necative.

Gelatin: No liquefaction.

Agar colonies. Circular, smooth, white, rossed and onaque. Margins entire to slightly undulate.

Broth: Shightly turbid throughout. No nellicle or ting.

Milk: Alkaline.

Nitrites not produced from nitrates. Indofe put formed.

No neid or gas in peptone broth plus sugars.

Starch not hydrolyzed.

Optimum temperature 25° to 25°C. Distinctive characters: Differs from

Pseudorionas sojae (Pseudomonas cl. cineal in the smaller size of cell, and absence of pellicle and dense clouding of broth. The pathogen does not infect soy bean.

Source: Isolated from the leaf spot of velvet bean.

Habstat: Pathogenic on velvet bean, Sticolobium deeringianium.

Pseudomonas viciae Uyeda. (Uycda in Takimoto, Jour. Plant Protect , Japan, 2, 1915, 845; Bacterium viciae Nakata, see Elliott, Bact. Plant Pathogens, 1930, 259; Phytomonas riciae Magrou, in Haudurov et al., Dict d. Bact. Path , Paris, 1937, 430.) From L. vicia. vetch; M. L. Vicia, n generie name.

Rods. 0 5 to 0.8 by 1.2 to 2.0 microns. Motile with 2 to 4 polar flagella. Gram-

positive.

Green fluorescent pigment produced in culture.

Gelatin colonies; Pale white, glistening, finally turning brown. No liquefac-

Milk Coagulates and clears.

Nitrites not produced from nitrates. No H2S produced.

Facultative anaerobe.

Habitat Pathogenic on the broad bean (Vicia faba), the turnip (Brassica rapa), the carrot (Daucus carela) and the sweet potato (Ipomoca batalas).

Pseudomonas allicola Burkbolder. (Burkholder, Phytopath., 52, 1942, 146, Phytomonas allucola Burkholder, abid ) From L. allium, onion; ·cola, dweller.

Rods 07 to 14 by 1.05 to 2.8 microns Motile with 1 to several polar flagella, at times bi-polar. Gram-negative

Gelatin. Liquefaction.

Brown.

Beef-extract peptone agar streaks: Moderate in growth, white at first, later dirty in appearance, edges wavy, consistency viscid Medium deep brown.

Potato-glucose agar frequently be-

comes greenish Broth. Turbid with light pellicle.

Milk Cleared and htmus reduced. Neutral.

Nitrites produced from nitrates. Indole not produced.

Ilydrogen sulfide not produced.

Lipolytic action very strong

Acid but no gas from 1-arabinose, dxylose, rhamnose, glucose, d-galactose, fructose, d-lactose, maltose, sucrose, glycerol, mannitol and salicin. Alkali from salts of acetic, citric, formic, hippurie, lactic, malie, succinic, tartaric acids.

Starch not hydrolysed.

Slight growth in broth plus 4 per cent

Aerobic.

Optimum temperature 30°C. Maximum 41°C. Minimum 5°C,

Source: Seven isolates from storage rot of onion bulbs.

Habitat: Pathorenic on onion bulbs, Allium cepa.

124. Pseudomonas gardeniae Burkholder and Pirone. (Burkholder and Pirone, Phytopath., \$1, 1941, 194; Phytomonas gardeniae Burkholder and Piroae, abid.) From M. L. Gardenia, a generic name.

Rods: 0.75 by 2.4 microns. Motile with 1 to 2 polar flagella. Gram-nega-

Gelatin: Liquefaction.

Beef-extract peptone agar colonics: Growth fair, white to dirty gray and vis-

cid. Medium becoming dark brown. Potato-glucose agar: No brown color. Broth: Turbid with pellicle. Dark

brown. Milk: Soft curd with pellicle. Clears

in zones. Litmus reduced. Natrites produced from nitrates.

Hydrogea sulfide not produced.

Indole not formed.

Acid from glucose, galactose, xylose, rhamnose, sucrose, maltose, mannitol, glycerol, and salicin. Alkali produced from the salts of citric, malic, malonic, succinic, tartaric and hyppuric acids. Good growth in tyrosine and in asparagine broth.

Starch is not hydrolyzed.

Aerobic. Source: Eight isolates from leaf spots

of cardenias in New Jersey. Habitat: Pathogenic on leaves of Gar-

densa zasminoides.

125 Pseudomonas caryophylll Burkholder. (Burkholder, Phytopath., 31, 1941, 143; Phylomonas caryophylls, Burkholder, ibid.) From M. I. Caryophyllus, an old generic name.

Rods: 0.35 to 0.95 by 1.05 to 3.18 mierons. At times slightly curved. Mottle with 1 to several polar flagella. Frequently bipolar. Gram-negative.

Gelatin: Liquefaction after 3 to 4

Potato glucose agar colonies 3 to 4 mm in diameter, erreular, smooth, glistening, edges entire. Color is tan to gray mauve. Old culture dark brown Consistency butyrous.

Broth: Turbid with a white sediment Milk: Litmus slowly becomes blue Slight reduction at bottom of tube. No

clearing.

Nitrites produced from nitrates Also ammona and gas are produced in a synthetic nutrato medium. Asparagine, KNO<sub>2</sub> and NHLHPO<sub>2</sub> can be utilized

Indole not formed.

Hydrogen sulfide not formed.

Lipolytic action slight to moderate Acid from l-arabinose, d-xylose, rhamnose, glucoso, d-galactose, fructose, dlactose, maltoso, and sucrose, glycerol, mannitol, and saliem. Alkalı with sodium salts of acette, citric, formic, hippuric, lactic, malic, maleic, sucenne and lattaria acid.

Starch not bydrolyzed.

Aerobic.

Optimum temperature 30° to 33°C. Maximum 46°C. Minimum 5°C. or less Slight growth in broth plus 3 5 per cent

salt.
Source: Isolated first by L. K. Jones

and later by W H. Burkholder from dying carnation plants from Spokane, Washington. Twelve isolates used in description.

Habitat: Pathogenic on roots and stalks of the carnation, Dianthus caryophyllus.

126. Pseudomonas solanacearum Erw. Smith. (Bacillus solanacearum Erw. Smith, U. S. Dept. Agr., Div. Vcg. Phys. and Path., Bul. 12, 1896, 10; Bacterium solanacearum Chester, Ann. Rept Del. Col. Agr. Exp. Sta, 9, 1897, 73; Erw. Smith, Baeteria in Relation to Plant Discases, 3, 1914, 178; Phytomonas solanacearum Bergey et al., Manual, 1st ed., 1923, 185.) From L solanum nightshade, M. L Solanaceae, a plant family.

Probable synonyms Elliott (Bact. Plant Pathogens, 1930, 203) lists the following: Bacillus mechanae Uyeda, Cent f. Bakt, 11 Abt, 15, 1904, 327; Bacillus sesamı Malkoff, Cent. f. Bakt, 11 Abt, 16, 1906, 664; Bacillus musae Roer, Phytopath f., 1911, 45; Bacillus musaerum Zeman, Rev. Tacul. Agr. Univ., La Plat, 14, 1921, 17, Erremia nucotianae Bergey et al., Manual, 1st ed, 1923, 172; Phytomonae ricini Archibald, Trop. Agr., Tranidad, 4, 1927, 124

Description taken from Elliott (loc cit ), Rods: 0 5 to 1 5 microns. Motile with

a polar flagellum. Gram-negative. Gelatin: Nakata (Jour Sci. Agr. Soc. Tokyo, 294, 1927, 216) states there are

Tokyo, 294, 1927, 216) states there are two forms, one of which shows slight liquefaction The other shows no liquefaction

Agar colonies Small, irregular, roundish, smooth, wet-shining, opalescent, becoming brown.

Broth: Slight pellicle Broth turns brown.

Malk: Cleared without precipitation of casein.

Nitrates produced from nitrates.

Indole not formed
Hydrogen sulfide not produced (Burk.

holder)

Glucose, sucrose, glycerol, sodium

1938, 325).

Nitrogen sources utilized are ammonia, nitrates (KNO<sub>2</sub>) asparagine, tyrosine, peptone and glutamic acid, but not potassium nitrito (Mushin, loc. cit.).

Starch not hydrolyzed.

Garden, 9, 1922, 383; Reactrium alboprecipitans Elliott, Baet. Plant Path, 1930, 89; Phytomoras olboprecipitans Bergey et al., Manual, 3rd ed., 1930, 277.) From Latin albus, white and precipitans, precipitating, referring to the white precipitate produced in culture.

Rods: 06 by 1.8 microns, occurring singly or in pairs. Capsules present. Mottle with a polar flagellum. Gramnegative.

Gelatin. Not liquefied.

Nutrient agar colonics. White, circular, raised, smooth, sticky, with margins entire. Whitish discoloration of the medium.

Broth: Turbid in 24 bours. Heavy sediment in old cultures. Milk: Becomes alkaline and slowly

elcars

Nitrites produced from nitrates.

Indole not produced No HaS produced.

Acid but not gas from glucose, fructose, glycerol and mannitol. No acid from lactose, maltose or sucrose.

Starch is hydrolyzed

Optimum temperature 30° to 35°C. Maximum temperature 40°C. Minimum 0°C.

Acrobic

Distinctive characteristics. White precipitate in culture media.

Source: Isolated a number of times from foxtail grass.

Habitat . Pathogenic on fortail, Chactochlon lutescens and other grasses.

141. Pseudomonns petasitis (Takimoto) comb. nov. (Bacterium petasitis Takimoto, Ann. Phyt. Soc. Japan, 2, 1927, 55; Phytomonas petasitis Magrou, in Hauduroy et al., Dict. d. Bact. Path., Paris, 1937, 393.) From M. L. Petasites, a generic name.

Rods. 0 8 to 1.1 by 1.1 to 1.7 microns. Mottle with a polar flagellum. Gramnegative.

Gelatin. No liquefaction.

Beef agar colonics: White, circular or ameboid, butyrous.

Broth: Strong turbidity. Pellicle.

Milk: Congulated in 30 days.

Nitrites produced from nitrates with gas formation.

Indole not produced. No II:S produced.

No evident acid in peptone broth but gas from glucose, lactose and sucrose. Acid but not gas from glycerol.

Weak growth in broth plus 6 percent salt.

Optimum temperature 27° to 30°C. Maximum 47°C. Minimum approximately 5°C.

Source: Isolated from brown to black lesions on Petasites japonicus in Japaa. Habitat: Pathogenic on leaves of Petasites japonicus.

142. Pseudomonas ligalcola Westerdijk and Buisman. (De lopenzickte, Arnhem, 1929, 51.) From Latin, lignum, wood; -cola, dweller.

Rods: Single or short chains. Motils with 1 to several polar flagella. Gramnegative.

Gelatin: No liquefaction.

Malt agar streaks: Milk white with a

Broth: Turbid with light pellicle.

Milk: No coagulation. No acid. Nitrites not produced from aitrates.

Indole not formed. Starch hydrolysis slight.

Optimum temperature ±25°C.

Source: From vessels of elm wood showing dark discoloration, in Holland-Hahitat: Pathogenic in elm wood

143. Pseudomonas andropogoni (Erw. Smith) Stapp. (Bacterium andropogoni Erw. Smith, Bacteria in Relation to Plant Diseases, 2, 1911, 63; Elliott and Smith, Jour. Agr. Res , 58, 1929, 4; Stapp in Sorauer, Handbuch der Pflantenkrankheiten, 2, 5 Auf., 1928, 27; Phylomonas andropogoni Bergey et al, Manual, 376 ed., 1930, 276.) From M.

L. Andropogon, a generic name (a synonvm of Holcus).

Description from Elliott and Smith

(loc. cst.).

Rods: 064 by 1.76 microns Motile with one to several bipolar flagella Capsules. Gram-negative.

Gelatin · Feeble liquefaction or none Beef-extract agar colonies Slow-growing, round, smooth, glistening, viscid,

white.

Broth: Growth slow with moderate turbidity in 48 hours A thin pellicle Milk: Alkaline and clears

Nitrites not produced from mitrates

Indole not formed. No H2S formed.

Not lipolytic (Starr and Burkholder, Phytopath , 32, 1942, 601).

Acid but not gas from glucose, ambipose, fructose and vylose. No acid from sucrose, maltose, lartose, raffinose, glycerol and mannitol.

Starch partially digested.

Optimum temperature 22° to 30°C Maximum 37° to 38°G. Minimum 1 5°C Optimum pH 60 to 66. Maximum 8.3 to 86. Minimum 50.

Source: Ellintt used for her description 4 cultures isolated from lesions on some, sorehum and broom-corn

Habitat . Pathogenic on sorghum, Holeus sorghum.

144. Pseudomonas woodsii (Smith) woodsii Stevens. (Bacterium Smith, Bact, in Relation to Plant Discases, 2, 1911, 62, Stevens, Plant Disease Tungi, New York, 1925, 39; Phytomonas woodsif Bergey et al , Manual, 3rd ed., 1930, 256.) Named for A. F. Woods, American plant pathologist.

Description from Burkholder and Guterman, Phytopath., 25, 1935, 118. Rods: 0 67 by 1 56 microns. Motile

with a polar flagellum. Gram-negative. Gelatin: No linuefaction.

Beef-extract agar slants Growth slow and scant, fillform, creamy, butyrous. Broth: Turbid

Milk: Becomes alkaline but otherwise little changed.

Nitrites not produced from nitrates. Indole not formed.

No H.S forroad.

Not lipolytic (Starr and Burkholder, Phytopath , 32, 1942, 601).

Acid but not gas from glucose, fructose, galactose, arabinose, xylose, rhamnose, lactose, glycerol and mannitol. Athaline reaction from salts of acctic. eitrie, malic and succinic acids. Sucrose. maltose, salicin, and lactic and formic acids not fermented. Starch not hydrolyzed.

Slight growth in broth plus 3 per cent ealt.

Acrobic.

Source: Isolated from water-soaked lesions on carnation leaves

Habitat: Pathogenic on carnation. Dianthus caryophyllus,

Pseudomonas panici-miliacei (Ikata and Yamauchi) comb nov. (Bacterium panici-miliacei Ikata and Yamauchi, Jour Plant Protect., 18, 1931, 35; Phytomonos panici-miliacei Burkholder. in Manual, 5th ed , 1939, 201 ) 1-rom M L. Panicum milioceum.

Description translated by Dr. K. Togashi

Rods: 08 to 1.1 by 18 to 26 microns Motile, with a single flagellum. Gramnegative.

Gelatin: Not liquefied.

Potato-agar plates Growth moderate, whitish, then tinged with light orange, undulating margins.

Broth. Turbid, white pellicle formed. Milk. No congulation and slow diges. tion. Alkaline

Nitrites are produced from nitrates Indole not formed.

No II.S produced.

No acid and no gas from sucrose, glucose, lactose, giveered and sedium nitrate.

Starch not hydrolyzed.

Optimum temperature 30° to 35°C

Facultative anaerobe.

Source. Species first isolated from millet, Panicum miliaceum.

Habitat Causes a leaf stripe of Panicum miliaceum.

146 Pseudomonas sallciperda Lindeijer (Lindeijer, Inaug Diss, Univ. Amsterdam, 1932; Phytopath. Zisebr., 6, 1933, 373, Bacterium saliciperda Burgwitz, Phytopathogenio Bacteria, Leningrad, 1935, 106; Phytomonas saliciperda Magrou, in Hauduroy et al., Diet. d. Bact Path, Paris, 1937, 408) From L. saliz (salicies), willow; perdo, to destroy.

Rods 12 to 21 microns in length. Motile with a polar flagellum. Gramnegative

Gelatin. No liquefaction.

Beef wort agar colonies: Gray-white. Milk No acid nor congulation.

Nitrites produced (small amount) from nitrates

Indole formation slight.

No gas from earbolydrates.

Starch not hydrolyzed.

Facultative anaerobe.

Source. Isolated from wilted branches of willow and pathogenicity proved Habitat Pathogenic on willow, Salix

spp.

147 Pseudomonas eriobotryae (Takimoto) Dowson (Bacterium eriobotryae Takimoto, Jour Plant Protect, 18, 1931, 354, Phytomonas eriobotryae Burkholder, in Manual, 5th ed., 1939, 205; Dowson, Trans Brit Mycol. Soc., 26, 1943, 10.)
From M L Eriobotrya, a generic name.

Translated by Dr. K. Togashi. Rods 07 to 09 by 22 to 3.0 microns Motile, with 1 or 2 flagella Gram-

negative. Gelatin Not liquefied

Agar plates · Colonies appear after 3 days, white or hyaline, butyrous, margins entire.

Broth Moderately turbid, pellicle powdery, ring formed Milk: No congulation, peptonized slowly, Alkaline

Nitrites not produced from nitrates.

Indole not formed.

No H2S produced.

No acid or gas from glucose, sucrose, lactose and glycerol in broth.

Starch not hydrolyzed.

Temperature relations: Minimum below 4°C, optimum 25° to 26°C, and maximum 32°C. Thermal death point 51°C.

Aerobic.

Source: Species isolated from loquat, Eriobotrya japonica.

Habitat: Causes a bud rot of Eriobotrya japonica.

148. Pseudomonas wieringae (Elliott) comb nov. (Phytomonas betae Wieringa, Noderl. Tijdsehr. Hyg, Microbiol. on Serol., Leiden, 2, 1927, 148; Bacterium wieringae Elliott, Man. Bact. Plant Pathogens, 1930, 204; Phytomonas wieringae Burkbolder, in Manual, 5th ed., 1939, 206) Named for K. L. Wieringa, plant pathologist of Holland.

Because Bacterium betae Chester (Ann. Rept Dol Col. Agr. Evp. Sta , 9, 1897, 53) may be a pseudomonad, the species name proposed by Elliott has been retained.

Description from Elliott (loc. cst.).
Rods: 0.5 to 2 0 microns. Motile with

1 to 5 polar flagella Gram-negative.

Beef-agar colonies: Smooth, round,

white to grayish, fluorescent.

Milk: Cleared in 5 days Not co-

agulated.
Nitrites not produced from nitrates.

No gas from sugars.

Optimum temperature 28° to 30°C. Maximum 37°C. Minimum 4°C.

Source : Isolated from vascular rot of

beets in Holland.

Habitat: Pathogenic on beets, Beta vulgaris.

Appendix I\*: The following species are believed to belong in the genus Pseudomonas although descriptions are frequently incomplete.

Achromobacter pellucidum Harrison. (Canadian Jour. Res., 1, 1929, 236.) Isolated from halibut. For a description of this species, see Bergey et al., Manual,

5th ed., 1939, 619.

Bacillus aurantiacus tingutarus Remlinger and Bailly. (Mance Medical, No 150, 1935; See Lasseur, Dupaix and Babou, Trav. Lab. Microbiol. Fac. Pharm. Nancy, Fasc. 8, 1935, 41.) From water. Dissociates readily. Related to Pseudomonas fluorescens aureus Zimmermann, See n. 648.

Bacillus cyaneoftworescens Zangemeister. (Cent. f. Bakt., I Abt., 18, 1895, 321; Pseudomonas cyaneoftworescens Migula, Syst. d. Bakt., 2, 1900, 906) From blue

milk.

Bacillus fluorescens nicalis Essenberg Eline Gletscherbakteric, Schmelek, Cent. f. Bakt., 4, 1885, 545; Eisenberg, Bakt. Dieg, 3 Aufl., 1891, 77.) From the melting snow of a facier. Probably a synonym of Pseudomonas Juorescens.

Bacillus lactis saponacei Weigmann and Zirn. (Cent. f. Bakt, 16, 1891, 468)

From soapy milk.

Bacterium auxinophilum Jacobs. (Ann. Appl. Biol, 22, 1935, 619) A Gram-negative organism with a polar flagellum which liquefies gelatin rapidly.

Bacterium bosporum Kalninš. (Latvijas Universitātes Raksti, Serija I, No. 11, 1930, 259.) Decomposes cellulose. Single polar flagellum. From soil.

Bacterium briosi Favarino (Atti Ist. Bot. d. R. Univ. di Pavia, Ser 2, 12, 1910, 337.) The natural bost is Lye-persicon esculentum. Pavarino (Rev. di Patol. Veg. 6, 1913, 161) states that this organism and Phytobacter lyeopersacum Groenewego (Meded Rijks Hoogero Land, Tuin- en Boschbouwechod, Dell S, 6, 1912, 217) should be considered identi-

cal. It closely resembles Bacterium tesicatorium Doidge (Jour. Dept. Agr. So. Africa, 1, 1920, 718) according to Gardner and Kendrick (Jour. Agr. Res., 21, 1921, 140).

Bacterium elaphorum Kalnins. (Latvijas Ūniversitātes Raksti, Serija I, No. 11, 1930, 257.) Decomposes cellulose Single polar flagellum. From soil.

Bacterium fraenkelii Ilashimoto. (Zeit i Ilyg, 51, 1899, 88.) A pleomorphic polar flagellate bacterium. From milk,

Batterium gummis Comes. (Comes, Napoli, Maggio 18, 1884, 14; sec Comes, Atti d. R. Ist. d'incoraggiamento alli Sc., Scr. 3, 5, 1884, 4; Batilius gummis Trevisan, I generi e le specie delle Batternace, Milano, 1889, 17.) Pathogenic on grapes, Yilis spp.

Bacterium krameriani Pavarino, (Atti R. Accad. Naz. Lincel Rend. Cl. Sci. Fis., Mat. et Nat., 20, 1911, 233.) Pathogenic on the orchid, Oncidium

krameriani.

Bactersum pusiolum Kalninš. (Latvijas Universitātes Raksti, Scrija I, No 11, 1930, 261.) Decomposes cellulose. Single polar flagellum. From manure.

Bacterium protozoides Kalnins. (Latvijas Universitātes Raksti, Serija I, No. 11, 1930, 263) Decomposes cellu-

lose. Single polar flagellum. From soil.

Pseudomonas acuta Migula (Culture
No. 11, Lemble, Arch. f. Hyg, 29, 1897,
317: Migula, Syst. d. Bakt., 2, 1900, 921.)

From the intestine.

Pseudomonas alba Migula. (Bacillus fluorescens albus Zimmermann, Bakt. unserer Trink- u. Nutxa6sser, I Reihe, 1899, 18, Migula, Syst. d. Bakt., \$2, 1900, 909.) From water. Bacillus fluorescens non liquefaciens Eisenberg, Bakt. Ding, 3 Aufl., 1891, 145 may be identical according to Migula (loc. etc.).

Pseudomonas allii (Griffiths) Migula. (Bactersum allium Griffiths, Proc. Roy. Soc. Edinburgh, 51, 1887, 40; Migula,

<sup>\*</sup> Appendixes I and II prepared by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, July, 1913.

Syst. d. Bakt., 2, 1900, 932) From rotted onions.

Pseudomonas aquatilis Migula. (Tataroff, Inaug. Diss., Dorpat, 1891, 31; Migula, Syst. d. Bakt., 2, 1900, 933.) From water. Said to form spores.

Pseudomonas aromatica Migula. (Bacillus crassus aromaticus Tatarofi, Innug. Diss , Dorpat, 1891, 27; Migula, Syst. d. Bakt., 2, 1900, 880.) From water.

Pseudomonas aromatica var. quercilopyrogallica Kluyver, Hof and Boezaardt. (Enzymologia, 7 1939, 28.)

Pseudomonas articulata Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 402.) From the stomachs of birds.

Pseudomonas aucubicola Trapp. (Phytopath, 26, 1936, 264.) Isolated from Aucuba japonica Not pathogenic.

Pseudomonas aurea Migula (Bacillus fluorescens aureus Zimmermann, Bakt. unserer Trink- u. Nutzwässer, I Reihe, 1890, 14; Migula, Syst. d. Bakt., 2, 1900, 931.) From water.

Pseudomonas braasicae acudae Gruber (Cent f Bakt., II Abt., 22, 1909, 558). From sauerkraut Identical with Bacterium brassicae acidae Conrad (Arch. f Hyg., 28, 1897, 75) according to Lehmann and Neumann (Bakt Diag., 5 Aufl., 2 1912, 380)

Pseudomonas butyr: Migula. (Bacillus butyr: fluorescens Lafar, Arch. f Hyg., 13, 1891, 19; Migula, Syst. d. Bakt, 2, 1900, 894.) From butter.

Pseudomonas calciphila Molisch. (Cent. f Bakt, II Abt, 65, 1925, 136.) From fresh water. Deposits CaCO<sub>2</sub>.

Pseudomonas calco-acetica Clifton. (Enzymologia, 4, 1937, 246.)

Pseudomonas capsulata Migula. (Syst. d. Bakt , 2, 1900, 915; not Pseudomonas capsulata Bergey et al., Manual, 1st ed., 1923, 124.) Similar to Pseudomonas macroselmis Migula.

Pseudomonas caryocyanea (Dupaix) Beijerinek. (Bacillus caryocyaneus Dupaix, Thesis, Univ. of Nancy, 1933, 1; Beijerinek, see Dupaix, tòid., 13; Bac-

terium caryocyancum Dupaix, ibid., 246.) Isolated from rotten willow wood, from yeast mash and beer-wort. Name appears first as Bacillus carvocvaneus on a culture sent by Beijerinek from Delft, Holland to the National Collection of Type Cultures, Lister Institute, London. Regarded by Dupaix as closely related to Bacillus cyaneo-fluorescens Zangemeister (Cent. f. Bakt., I Abt., 18, 1895, 321; Pscudomonas cyaneo-fluorescens Migula. Syst. d. Bakt., 2, 1900, 906); Der blaue Bacillus, Mildenberg (Cent. f. Bakt., II Abt., 56, 1922, 309; Pseudomonas mildenbergii Bergey et al., Manual, 3rd ed., 1930, 172); and Bacillus pyocyaneus Gessard (Compt. rend. Acad. Sci. Paris, 94, 1882, 536).

Pseudomonas calarrhalis Chester. (Bacillus der Hundestaupe, Jess, Cent. f. Bakt., II Abt., 25, 1899, 541; Chester, Man. Determ. Bact., 1001, 308.) Isolated from catarrh in dogs.

Pseudomonas cariae Scherago. (Jour-Bact., \$1, 1936, 83; Jour. Inf. Dis., 60, 1937, 215.) Cause of an epizootic septicemia in guinea pigs.

Pseudomonas chlorophaena Migula. (Syst. d. Bakt., 2, 1900, 899.)

Pseudomonas cocacea Migula. (Culture No. 10, Lembke, Arch. f. Hyg, 29, 1897, 317; Migula, Syst. d. Bakt., 2, 1900, 924.) From the intestine.

Pseudomonas cohaerea (sie) (Wright) Chester. (Bacillus cohaerens Wright, Mem. Nat. Acad. Sci., 7, 1895, 464; Chester, Man. Determ. Bact, 1901, 312.) From water.

Pseudomonas coli Migula. (Culture No. 8, Lembke, Arch. f. Hyg., 29, 1897, 315; Migula, Syst. d. Bakt., 2, 1900, 920) From the intestine.

Pseudomonas colloides Miguls-(Bacıllus fluorescens putidus colloides Tataroff, Inaug. Diss., Dorpat, 1891, 495 Migula, Syst. d. Bakt., 2, 1900, 902.) From water. Said to form spores.

Pseudomonas conradi Lehmann and Neumann. (Bakt. Diag., 5 Aufl., 2, 1912, 394.) Red pigment.

Pseudomonas delahens (Wright) Chester, (Bacillus delabens Wright. Mem. Nat. Acad. Sci., 7, 1895, 456. Chester, Man. Determ. Bact. 1901.

314 ) From water

Pseudomonas dunlex Migula (Culture No. 7. Lembke, Arch. I. Hye., 29. 1897, 314; Migula, Syst d. Bakt., 2, 1900, 922.) From the intestine.

Pseudomonas ellineoidea Mienla. (Racillus conenes fluorescens & Zorkendörfer, Arch. I. Hvg., 16, 1893, 393; Migula, Syst. d. Bakt., 2, 1900, 925) From hens' erres.

Pseudomonas enhemerocuanea Fuller and Norman, (Jour. Bact . 46, 1913, 274.) From soil. Decomposes cellutose

Pseudomonas eruthra Fuller and Norman. (Jour. Bact., 46, 1943, 276.) From soil. Decomposes cellulose.

Pseudomonas eruthrospora (Colin) Migula. (Racillus eruthrosporus Colin. Beitr. z. Biol. d. Pflanzen, S. Heft 1, 1870, 128; Migula, in Engler and Prantl, Die naütri, Pflanzenfam., 1, la, 1895, 29 ) From air, meat infusion and nater. Said to form spores.

fimbriata Pseudomonas (Wright) Chester. (Bacillus fimbriatus Wright, Mem, Nat. Acad. Sci. 7, 1895, 463, Chester, Man. Determ. Bact , 1901,

313 ) I'rom water.

l'seudomonas fluorescens exiliosus van Hall. (Ztschr. I. Pflanzenkr., 15, 1903, 132.) Causes soft rot of shoots and bulbs of iris (Iris app.).

Pseudomonas foliacea Chester (Racillus fluorescens foliaceus Wright, Mem. Nat. Acad. Sci. 7, 1995, 439, Chester, Man. Determ. Bact , 1901, 321, Bacillus fluorescens-foliaceus Chester, ibid.) From water. Very similar to Pseudomonas incognita Chester.

Pseudomonas casoformans (I'm neuer grabildender Bacillus, Gartner, Cent. f. Bakt., 18, 1991, 1; Migula, Syst. d. Bakt., 2, 1900, 883 ) Gas bubbles in gelatin stab

Pseudomonas gracilis Migula, (Syst. d Balt. # 1900 888 ) Mornhologically like Pseudomonas fluorescent Migula

Preudomonas granulata Kern (Arb. bakt. Inst Karlsruhe t Helt 4 1896 464 ) From the stomach and intestine of hinds

Pseudomonas halestoraus Clazari. Volcani. (Ph.D Thesis, Hebrew Univ., Jerusalem, 1940.) A halophilic pseudomonad Imm the Dead Sea

Pseudomonas hydrosulfurca Migula. (Recillus cocenes hudrosulfureus & Zorkendörfer, Arch 1 Hyg., 16, 1893, 385; Micula, Syst. d. Bakt., 2, 1900, 898.) From hens' core

Pseudomonas iridis van Ilall. (Van Hall, Thesis, Univ Amsterdam, 1902 and Zischr. f. Pflanzenkr., 18, 1903, 129; Bacterum iridis Elliott, Man. Bact. Plant Path., 1930, 142, Phytomonas sridis Magrou, in Haudurov et al., Diet. d. Bact Path , Paris, 1937, 369.) Causes a rot of bulbs and leaves of itis (Iris ann.).

Pseudomonas sris (Frick) Migula. (Bacillus iris Frick, Arch. I. path. Anat., 116, 1889, 292; according to Lisenberg, Bakt, Diag., 3 Aufl., 1891, 148; Migula. Syst d Bakt., 2, 1900, 931.)

Pseudomonus statica (Fol and Chinpella) Reinelt (Quoted from Lehmann and Neumann, Bakt Diag., 7 Aufl., 2. 1927, 367.) Phosphorescent.

Pseudomonas jaranica (Lijkmann) Migula (Photobacterium jaranense Linkmann, Generak Taidechr. Nederl -Indie, 57, 1892, 109; Abst. in Cent f Bakt , 12, 1902, 636, Bacillus tarantensia Dyar, Annala New York Acad Sci . 8, 1895, 359, Bacterium jarameners Cleater, Man. Determ Bact, 1901. 170. Photologeterium jaranicum Lehmann and Neumann, Bakt Ding , 1 Auff. 2, 1996, 199, Migula, Syst. d. Bakt., 2, 190), 953) I'rom eca fish in Java. Hue green luminescence.

Presilement laction Weses (Arb bakt. Inst. Karloube, c. Helt 3, 1992, 238) From a tegetable infusion

Pseudoronas Jana Fuller and Norman

(Jour. Baet., 46, 1943, 275.) From soil. Decomposes cellulose.

Pseudomonas lembkei Migula. (Culture No. 12, Lembke, Arch. f. Hyg., 29, 1897, 318; Migula, Syst. d. Bakt., 2, 1900, 896.) From the intestine.

Pseudomonas liquefociens (Tataroff) Migula. (Bacillus liquefaciens Tataroff, Inaug. Diss., Dorpat, 1891, 29; Migula, Syst. d. Bakt., 2, 1900, 876.) From water.

Pseudomonas lister: Weiss. (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 260.) From a vegetable infusion.

Pseudomonas longa Migula. (Bactllus fluorescens longus Zimmermann, Bakt, unserer Trink- u. Nutzwässer, I Reihe, 1890, 20; Migula, Syst. d. Bakt., 2, 1900, 907) From water.

Pseudomonas macroselmis Migula. (Bacıllus fluorescens putidus Tataroff, Inaug. Diss., Dorpat, 1891, 42; Migula, in Engler and Prantl, Die natürl. Pflanzenfam 1, 1a, 1895, 29.) From water.

Pseudomonos maidis (Eisenberg) Migula. (Bacillus maidis Eisenberg, Bakt. Ding, 3 Aufl, 1891, 119; Migula, Syst. d. Bakt., 2, 1900, 877.) From corn grains soaked in water and from feces of pellagra patients.

Pseudomonas maschekti Migula. (Blaugrüner Bacillus, Maschek, Bakt. Untersuch. d. Leitmeritzer Trinkwasser, Jabresber. d. Oberrealschule zu Leitmeritz, 1887, Migula, Syst. d. Bakt. 2, 1909, 916.) From water.

Pseudomonas melochlora (Winkler and Schotter) Migula (Baeillus melochioros Winkler and Schrötter, Ein neuer grünen Tarbstoff entwickelnder Bacillus, Wien, 1890; Migula, Syst. d Bakt., 2, 1900, 893) From eaterpillar foces

Pseudomonas mesenterica Migula. (Bacillus fluorescens mesentericus Tataroff, Inaug. Diss, Dorpat, 1891, 38; Migula, Syst. d. Bakt., 2, 1900, 903.) From water

Pseudomonas metalloides Migula. (Bacillus rosaceus metalloides Tataroff, Inaug Diss., Dorpat, 1891, 65; not Bacterium rosaceus metalloides Dowdeswell, Ann. de Microgr., 1, 1888-89, 310, see

Heffernan, Cent. f. Bakt., Il Abt., 8, 1902, 689; Pseudomonas rosacea Migula, in Engler and Prantl, Dio natürl. Pflanzenfam., 1, 1a, 1895, 29; Migula, Syst. d. Bakt., 8, 1900, 938.) Single flagellum. Rabata and yellow-red pigment. From water.

Pseudomonas minutissima Migula. (Bacillus fluorescens liquefacina minutissimus Unna and Tommasoli, Monatsh. f., prakt. Dermat., 8, 1889, 87, according to Eisenberg, Bakt. Diag., 3 Aufl., 1891, 76; Migula, Syst. d. Bakt., 2, 1900, 891.) Found on human skia in cases of seborrhole ecrema.

Pseudomonas mobilis Migula. (Culture No. 9, Lembke, Arch. f. Hyg., 29, 1897, 316; Migula, Syst. d. Bakt., 2, 1900, 923.) From the intestine.

Pseudomonas monadiformis (Kruse) Chester. (Bocillus coli mobilis Messca, Riv. d'Igicne, Rome, 1890; Bacillus monadiformis Krusc, in Flügge, Die Mikroorganismen, 2, 1896, 374; Chester, Man. Determ. Bact., 1901, 303.) From typhoid stools.

Pseudomonos mucidolens Levine sad Anderson. (Jour. Bact., 23, 1932, 337.) Causes musty odors in eggs. Also milk (Olsen and Hammer, Iowa State Coll-Jour. Sci., 9, 1934, 125).

Pseudomonas mucidolens var. tarda Levine and Anderson. (Jour. Bact., 25, 1932, 337.) Causes musty odors in egss. Pseudomonas nezibilis (Wiight) Chester. (Bacillus nezibilis Wright) Mem. Nat. Acad. Sci., 7, 1895, 41. (Chester, Man. Determ. Bact., 1901, 309.)

Pseudomonas nivalis Szilvinyi. (Cent. f. Bakt., II Abt., 84, 1936, 216.) A red chromogen isolated from red snow in Austria.

From water.

Pseudomonas ochroleuca Miguls. (Bacillus 7, Zörkendörfer, Arch. f. Hyg., 16, 1893, 396; Migula, Syst. d. Bakt., \$, 1900, 897.) From hens' eggs.

Pseudomonas oogenes Migula. (Bacillus oogenes hydrosulfureus 5, Zörkendörfer, Arch. f. Hyg., 16, 1893, 386; Migula, Syst. d. Bakt., 2, 1900, 878.) Single flagellum. From hens' eggs.

Pseudomonas ovi Migula. (Bacillus oogenes "

Bakt., 2
Pseudomonos ovicola Migula. (Bacillus oogenes fluorescens y, Zörkendörfer, Arch. f. Hyg., 16, 1893, 394; Migula, Syst. d, Bact., 2, 1900, 925.) From hens'

Pseudomonas pallescens Migula. (Bacillus viridis pallescens Frick, in Virchow, Arch. f. path. Anat., 116, 1859, 202; according to Eisenberg, Bakt Diag, 3 Aufl., 1891, 154; Migula, Syst. d. Bakt., 2, 1990, 207; Source not given

Pseudomonas ponsinii Migula (Bacillus fluorescens non liquefaciens Pansini, in Virchow, Arch. f. path Anat, 122, 1890, 452; Migula, Syst d. Bakt., 2,

1900, 926,1

POOR

Pseudomonas pelliculosa Migula. (Bacillus cogenes fluorescens t, Zörkendörfer, Arch. f. Hyg., 16, 1893, 395; Migula, Syst. d. Bakt., 2, 1900, 926) From hens' ecros.

Pseudomonas pellucida Kern (Arb bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 465.) From the intestine of birds

Pseudomonas plehniae Spieckermann and Thienemann. (Arch f. Hyg., 74, 1911, 110.) Isolated from carp Pathogenic for many species of fish.

Pesudomonas plicala (Frankland and Frankland) Migula. (Bacillus plicalus Frankland and Frankland, Phil. Trans Roy Soc. London, 178, B, 1887, 273; Migula, Syst. d. Bakt., 2, 1900, 881.) From sir.

Pseudomonas pseudotyphosa Migula. (Typhusähilicher Bacillus, Lustig, Diag. d. Bakt. d. Wassers, 1893, 16; Migula, Syst. d. Bakt. 2, 1900, 893.) From water.

Pseudomonas pullulans (Wright) Chester. (Bacillus pullulans Wright, Mem. Nat. Acad. Sci., 7, 1894, 415; Chester, Man Determ. Bact., 1901, 315) From water. Pseudomonas protea Frost. (U. S. Public Health Ser., Hyg. Lab. Bull. 66, 1910, 27.) From filtered river water. Can be neglutinated by specific typhoid immune-serum.

Paeudomonas rosea Chester. (Bocillus roseus vini Bordas, Joulin and Rackowski, Compt. rend. Acad. Sci. Paris, 128, 1888, 1859; Chester, Man. Determ Bact., 1901, 327; not Pseudomonas rosea Migula, in Engler and Pranti, Die natürl. Pillanzenfam., 1, 1a, 1895, 30.) From wine. Said to form sores.

Pseudomonas (Hydrogenomonas) saccharophila Doudoroff. (Enzymologia, 9, 1940, 50.) From stagnant water.

Pseudomonas sapolaetica (Eichholz) De Rassi. (Bacterium sapolaeticum) Eechholz, Cent. f. Bakt., II Aht., 9, 1902, 631, De Rossi, Microbiologia Agraria o Technica, Torino, 1927, 693.) Isolated from sony milk.

Pseudomonas sericea Migula. (Seidenglanzender Bacillus, Tataroff, Inaug. Diss, Dorpat, 1891, 26; Migula, Syst d.

Bakt., 2, 1000, 882.)

Pseudomonas tenuis Migula. (Bacillus fluorescens tenuis Zimmermann, Bakt. unserer Trink. u. Nutzwässer, I Reihe, 1800, 18. Migula, Syst. d. Bakt., 2, 1900, 910.) From water.

Pseudomonas trommelschlägel (Ravenel) Chester. (Bacillus trommelschlägel Ravenel, Mem. Nat. Acad. Sci., 8, 1896, 26; Chester, Man Determ Baet., 1901, 327.) From soil. Said to form snores.

Pseudomonas undulata Chester. (Bacillus fluorescens undulatus Ravenel, Mem Nat. Arad. Ser., 8, 1896, 20; Chester, Man. Determ. Bact., 1901, 323) Trom soil Said to form spores

Pseudorionas rírescens (Frick) Migula (Bacillus rirescens Frick, Arch. f. path. Anat., 116, 1889, 292; Migula, Syst. d. Bakt., 2, 1900, 916) From green sputum.

Pseudomonas viridans (Symmers) Migula (Bacillus viridans Symmers, Brit. Med. Jour., No. 1615, 1891, 1232; Abst in Cent. f. Bakt., 12, 1892, 165; Migula, Syst. d. Bakt., 2, 1900, 890.) From water. Pseudomonas viridescens Chester. (Bacillus viridescens liquefaciens Ravenel, Mem Nat. Acad. Sci., 8, 1896, 24; Chester, Man. Determ. Bact., 1901, 323.) From soil. Said to form spores.

Pseudomonas riridis Migula. (Bacillis der grunen Diarrhoe der Kınder, Lesage, Arch. d. Physiol norm. et path., 20, 1888, 212, see Eisenberg, Bakt. Diag., 3 Aufl., 1891, 238, Migula, Syst. d. Bakt., 2, 1900, 886, 59, From intestine of children,

Pseudomonas weigmanni Migula, (Bakterie IV, Weigmann and Zirn, Cent. f. Bakt, 15, 1891, 466; Migula, Syst. d. Bakt, 2, 1900, 892) From soapy milk.

Pseudomonas zörkendörferi Migula. (Bacıllus oogenes fluorescens α, Zörkendorfer, Arch f Hyg, 16, 1893, 392; Migula, Syst. d Bakt, 2, 1900, 897.) From hens' eggs.

Appendix II: The following polar fingellate organism has been described from activated studge II. Winogradsky has also described polar fingellate forms from the same source that form zooglees. (Compt. rend. Acad Sci. Paris, 200. 1935, 1887; Ann. Inst. Pasteur, 58, 1937, 333).

Zoogloca ramilera Kruse emend. Butterfield. (Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 1, 1896, 68; Butterfield, Public Health Reports, 50, 1935, 671; Culture No. 50, Wattie, Pub-Health Reports, 57, 1942, 1819.)

Rods: 1 by 2 to 4 microns, with rounded ends. Non-spore-forming. Capsules present. Motile with a single long polar flagellum. Gram-negative.

Gelatin: No liquefaction.

Grows better in aerated liquid media.

Agar: Scant growth,

Indole not formed.

No H2S produced.

No acid or gas from carbohydmtes. Nitrites not produced from nitrates.

Optimum pH 7.0 to 7.4.

Optimum temperature 28° to 30°C. Good growth at 20° and at 37°C. Minimum temperature 4°C.

Strict acrobe.

Distinctive character . Oxidizes sewage. Source: Isolated from activated sludge. Habitat: Produces zoogloenl masses in activated sludge.

## Genus II. Xanthamonas Dowson\*

(Phytomonas Bergey et al., Manual, 1st ed., 1923, 174; Dowson, Cent. f. Bakt., II Abt., 100, 1939, 187)

Cells usually monotrichous, with yellow, water-insoluble pigment. Proteins are usually readily digested. Alilk usually becomes alkaline. Hydrogen sulfide is produced. Asparagin is not sufficient as an only source of carbon and nitrogen. Acid is produced from mono- and disaccharides. Mostly plant pathogens causing necrosis From Gr. xanthus, yellow; monas, a unit; M. L. monad.

The type species is Xanthomonas hyacinthi (Wakker) Dowson.

Key to the species of genus Xanthomonas.

- 1. Colonies yellow.
  - a Gelatin liquefied.
    - b. Starch hydrolysis feeble.
      - e. Nitrites not produced from nitrates.
        - Xanthomonas hyacinthi.
          - 2. Xanthomonas pruni.
          - 3, Xanthomonas vitians.

<sup>\*</sup> Prepared by Prof. Walter H. Burkholder, Cornell Univ., 1thaca, N. Y., June, 1943.

- ec. Nitrites produced from nitrates.
  - 4 Xanthomonas beticola. 5. Xanthomonas lactucae-scariolae.
    - Xanthomonas rubrelineans
- bb. Starch hydrolysis strong
- c. Nitrites not produced from nitrates. d No brown pigment in beef-extract agar.
  - Xanthomonas barbarcac.
    - Xanthomanas begoniac. R
      - Xanthomonas campestris.
    - 9a Nanthomonas campestris var. armoraciae
    - 10. Nonthomonas citti.

    - Xanthomonas corylina. 11
    - Xanthamonas cucurbitac. 13 Xanthomonas dieffenbachiae.
    - 14 Nanthomonas holeicola.
    - Nanthomonas incanac.
    - 15
    - Xanthomonas jugiandis. Xanthomonas lespede:at. 16
    - Nanthomonas malractarum. 17
    - Xanthomonas pelargonii. 18
    - Nanthomonas phascoli. 19
    - 20a Nanthomonas phaseoli var. sojense
    - 21. Xanthomonas plantaginis.
    - - Xanthomonas ricinicola
    - 23a Nanthomonas translucens I sp hordes 23b Nanthomonas translucens i sp undulora.
    - 23c Xanthomonas translucens i ap secolis. 23d Nanthomonas translucens [ sp horder-arenae
    - 23e Xahthomonas translucens f ap cereolis

    - 21 Xanthomonas rasculorum
      - Xanthomonas resiculoria
    - 25a Nanthomenas traicatorio var rophani
    - dd Brown pigment produced in beel-extrict media.
      - 26 Xantkomonas nakatae
      - 20b Xanthomonas phascals var fustans
    - cc. Nitrites produced from nitrates 27 Xanihamonas paparericola

    - ecc. Ammonis formed in nitrate media 2 Xanthamonas alfalfar
  - blib. Starck not hydrolyzed c Natrates produced from marales
    - Xanifornanas acernae ce Nitrites not produced from nitrates
      - 30 Xandamenas caridac
        - 31. Nantharanas bellerae
        - 32 Xanthoronas piermicela
      - 23 Xanthamonge remediation
      - ece Ammunia formed in nutrate media 33. Xanilamanas geranis

bbbb. Starch hydrolysis not reported.

c Nitrites produced from nitrates.

34. Xanthomonas antirrhini.

Xanthomonas heterocea.

cc. Nitrites not produced from nitrates.

36. Xanthomonas gummisudans.

37. Xanthomonas lactucae.

Xanthomonas nigromaculans.

aa. Gclatin not liquefied.

b. Starch not hydrolyzed.

39. Xanthomonas oryzae.

asa. Gelatin not reported.

b. Starch hydrolyzed.

40. Xanthomonas celebensis.

2. Colonics whitish to cream.

a. Gelatin liquefied.

b. Starch hydrolyzed.

c. Nitrites produced from nitrates.

41. Xanthomonas vanici.

42. Xanthomonas proteomaculans.

43. Xanthomonas manihotis.

cc. Nitrites not reported.

44. Xanthomonas rubrisubalbicans.

bb. Starch not reported.

45. Xanthomonas cannae.

46. Xanthomonas zingiberi.

47 Xanthomonas conjaci.

 Xanthomonas hyacinthi (Wakker) Donson. (Bacterium hugeinthi Wakker. Botan. Centralblatt, 14, 1883, 315; Bacillus hyacınthı Trevisan, I generi e le specie delle Batteriacce, 1889; 19; Pseudomonas hyacınthi Erw Smith, Bot. Gazette, 24, 1897, 188; Phytomonas . hyacinthi Bergev et al., Manual, 1st ed., 1923, 177; Dowson, Cent. f. Bakt., II Abt , 100, 1939, 188.) From Gr. hyacinthus, the hyacinth; M. L Hyacinthus, a generic name.

Description from Smith, Div. Veg. Phys and Path., U S. D. A. Bul. 26,

1901, 40. Rods: 0.4 to 06 by 08 to 2 microns. Motile with a polar flagellum. Filaments present. Gram-negative.

Gelatin · Slow liquefaction.

Agar colonics Circular, flat, moist, shining, bright yellow. Medis stained brown.

Milk: Cascin is precipitated and digested. Tyrosine crystals produced. Nitrites not produced from nitrates Indole: Slight production. Hydrogen sulfide is produced. Acid, no gas, from glucose, fructose,

galactose, sucrose and maltose.

Starch: Hydrolysis slight.

Optimum temperature 28° to 30°C. Maximum 34° to 35°C. Minimum 4°C. Aerobic, with the exception of maltose, where it is facultative anaerobic.

Habitat: Produces a yellow rot of hyacinth hulbs, Hyacinthus orientalis.

2. Xanthomonas pruni (Erw. Smith) Dowson. (Pseudomonas pruni Erw. Smith, Science, N. S. 17, 1903, 456; Bacterium pruni Erw. Smith, Bacteria in Relation to Plant Dis., 1, 1905, 171; Bocillus pruni Holland, Jour. Bact., 5, 1920, 220; Phylomonas pruni Bergey et

al., Manual, 1st ed., 1923, 179; Dowson, Cent. f. Bakt , II Abt., 100, 1939, 190 ) From L. prunus, plum; M L. Prunus, a generic name,

Probable synonym · Phytomonas cerasi wraggi Sackett, Col. Agr Exp Sta Rept . 38, 1925, 17; Pseudomonas cerasi uragai. ibid .; Bacterium cerasi wrages Elliott. Bact. Plant Pathogens, 1930, 111,

Description from Dunegan, U S Dept Agr., Tech. Bull. 273, 1932, 23

Rods: 02 to 04 by 05 to 10 microns Capsules. Motile with a polar flagellum. Gram-negative.

Gelatin: Liquefaction

Beef-extract agar colonics Yellow, circular, smooth, convex, edges entire Broth: Turbid becoming viscid

Milk: Precipitation of casem and digestion.

Nitrites not produced from nitrates

Indole not formed

Hydrogen sulfide not produced Hydrogen sulfide produced (Burkhalder) Lipolytic (Starr and Burkholder, Phy-

topath , 32, 1912, 600)

Acid from arabinose, xylose, glucose, fructose, galactose, mannose, maltose, lactose, sucrose, raffinose, melezitose Starch is hydrotyzed (slight)

Aerobic.

Optimum temperature 21° to 29°C Maximum 37°C.

Source: Smith isolated the pathogen

from Japanese plums. Habitat: Pathogenic on plum (Prunus

salicina), peach (P persien), apricot (P. armenicca), etc

3. Xanthomonas vitians (Brown) Start and Weiss (Bacterium ritions Brown, Jour. Agr. Res., 13, 1918, 279, Phylomonas rilians Bergey et al., Manual, 1st ed., 1923, 183; Pseudomonas ritians Stapp, in Soraver, Handb. d. Pflanzenkrank, 2, 5 Aufl., 1928, 287; Starr and Weist, Phytopath., 33, 1943, 316 ) From Latin, ritians, injuring, infecting.

Rods: Motile with bipolar flagella. Gram-negative

Gelstin: Slow liquefaction.

Beef-extract agar colonies: Circular. smooth, thin, cream to cream-yellow.

Broth: Turbid with yellow ring, Milk: Clears and turns alkaline. Nitrites not produced from nitrates.

Indole: Feeble production. Hydrogen sulfide: Peoble production,

Acid but not gas from glucose. Starch: Feeble hydrolysis.

Optimum temperature 26" to 25°C. Maximum 35°C. Minimum 0°C. Aembie.

Source: Isolated from the stem of diseased lettuce plants from South Camlina.

Habitat: Pathogenie on lettuce, Loctuca satira.

4. Xanthomonas beticola (Smith. Brown and Townsend) comb, nor tersum beticolum Smith, Bronn and Townsend, U. S. Dept. Agr , Bur. Plant Ind., Bul. 213, 1911, 191; Pseudomonas beticala Holland, Jour. Bact., 5, 1920, 224; Phytomonas beticola Bergey et al., Manual, 1st ed , 1923, 182 ) From Latin, beta, beet, -cola, dweller,

Description from Brown, Jour Agr. Res. 37, 1028, 167, where the species is referred to as Bactersum beticola (Smith. Brown and Townsend) Potebnia

Rods · O 4 to 0 8 by 0 6 to 20 microns Motile with I to 4 polar flagella sules Gram-variable

Gelatin . Liquelaction.

Beef-agar slants' Moderate fillform growth, first, glistening, yellow.

Broth: Turbid, rellow ring, abundant sediment.

Milk . Congulation and pentonization, Indole not formed.

Hydroren sulfide formed.

Natrites produced from nitrates.

Acid from glucose, sucrove, maltowe, mannitol. No acid from lactose.

Starch hydrolysis feeble.

Optimum temperature 23°C. Maximum 39°C. Minimum 1.5°C.

Optimum pH 65. Maximum 9.0 to 9.5. Minimum 4.5 to 48.

Tolerates salt up to 9 per cent.

Aerobic.

Source: Isolated from galls on sugar beets collected in Colorado, Kansas, and Virginia.

Habitat: Produces gall on sugar beets and on garden beets.

Note: It is doubtful whether this species belongs in this genus

5. Xanthomonas lactucae-scariolae (Thornberry and Anderson) comb. nov. (Phytomonas lactucae-scariolae Thornberry and Anderson, Phytopath., 27, 1937, 109.) From Lactuca scariola, the host,

Rods 05 to 10 by 1.0 to 1.5 microns. Motilo with 1 or 2 polar flagella. Chains present. Capsules Gram-negative.

Gelatin Slow liquefaction

Glucose agar colonies. Round, entire, finely granular, amber yellow.

Broth. Turbid. No pelliclo. A yel-

Milk: Slight acid, and peptonization Nitrites are produced from nitrates. Hydrogen sulfide not formed.

No gas from carbon sources.

Starch: Slight diastatic activity.

Optimum temperature 25°C, Maximum 35°C Minimum 7°C

Aerobic.

Source Isolated from necrotic lesions on wild lettuce.

Habitat. Pathogenic on wild lettuce, Lactuca scariola, but not on cultivated lettuce, Lactuca sativa.

6. Xanthomonas rubrillneaus (Lee et al.) Starr and Burkholder. (Phylomonas rubrillneaus Lee, Purdy. Barnum and Martin, Hawaiian Sugar Planters' Assoc. Bull., 1925, 25; Pseudomonas rubrilineaus Stapp, in Sorauer, Handb. d. Pflanzenkrank, 2, 5 Aufl, 1928, 35; Bacterum rubrilineaus Elliott, Man. Bact. Plant Path, 1930, 195; Starr and Burkholder, Phytopath., 32, 1942, 600.) From L ruber, red; lineaus, striping

Rods: 0.7 by 1.67 microns. Motile with 1 or seldom more polar flagella Gram-negative.

Gelatin: Liquefaction.

Agar (Beef-extract + glucose) colonies: Small, smooth, glistening, buff to yellow.

Broth: Turbid with pellicle. Sedient.

Milk: Casein precipitated and digested. Nitrites are produced from nitrates Indole not produced.

Hydrogen sulfide not formed.

Not lipolytic (Starr and Burkholder, Phytopath., 32, 1942, 600).

Acid from glucoso, fructose, arabinose, xylose, lactose, sucrose, raffinose and mannitol.

Starch: Slight hydrolysis.

Growth range, pH 5 4 to pH 7.3. Facultative anaerobe.

Source: Description from 3 cultures isolated from the red stripe lesions in sugar cane.

Habitat: Pathogenic on sugar canc.

7. Xanthomonas bsrbareae Burkholder. (Burkholder, Phytopath., 51, 1941, 348-Phytomonas barbareae Burkholder, bid.) From M. L. Barbarea, a generic name. Rods: 0.4 to 0.95 by 1 0 to 3.15 microas. Motile with a single polar flagellum Gram-negative.

Gelatin: Liquefaction.

Beef-extract peptone colonies: Circular, yellow, smooth, butyrous, growth moderate.

Potato glucose agar: Growth abun-

dant, pale yellow. Mucoid.

Broth: Turbid, yellow granular ring-Milk: Soft curd, with clearing and production of tyrosine crystals Litmus reduced

Nitrates utilized but no nitrites formed. Asparagine and nitrites not utilized.

Hydrogen sulfide produced.

Indole not formed.

Lipolytic (Starr and Burkholder, loc. cut.).

Acid from glucose, galactose, xylose, maltose, sucrose, and glycerol. Alkali

produced from salts of malonic, eitrie, malic, and succinic acids. Rhamnose, salicin and hippuric acid salts not utilized.

Starch hydrolyzed. Aerobic.

Distinctive characters Similar to Xanthomonas campestris but does not infect cabbage, cauliflower or horseradish

Source: From black rot of winter cress, Barbarea vulgaris.

Habitat: Pathogeme on leaves and stems of Harbarea vulgaris

Xanthomonas begoniae (Talmoto). Donson. (Bacterium begoniae Talmoto, Jour. Plant. Protect, 21, 1931, 262, Pseudomonas begoniae Stapp. Arbeiten Biol. Richasnast f Land. und Forsta. 22, 1933, 392; Phylomonas begoniae Burkholder, in Manual, 5th ed., 1939, 162, Dowson, Cent. f Bakt, II Abt., 160, 1939, 190.) From M. L. Regonia, a generic name.

Probable synonyms: Bacterium begoniae Buchwald nom nud, GartnerTidende, 45, 1933, 1; Phytomonas flaa
begoniae Wieringa, Tudschr Plantischt, 41, 1935, 132; Bacterium flaaconada
McCulluch, Jour. Agr Res, 54, 1937, 859
(Xanthomonas flacozonatum Dowson, loc
cit).

Translated by Dr K. Togashi

Rods: 05 to 06 by 12 to 20 merons Motile with a polar flagellum Gramnegative.

Gelatin: No liquefaction Liquelaction (Wieringa, loc ett., McCulloch, loc. ett., Dowson, loc ett., and Stapp,

loc. cit.).
Potato agas colonics Circular, convex, smooth, moist, shining, yellow

Broth: Turbid. Yellow pethele and precipitation.

precipitation.

Milk: No congulation. Casein digested.
Alkaling

Nitrites not produced from nitrates

Indole not produced
Hydrogen sulfide produced
Liveletic Character Burkhalder P

Lipolytic (Starr and Burkholder, Plattopath., 22, 1942, 600)

Starch hydrolyzed (Dowson, Jour. Roy. Hort Soc , 63, 1938, 289)

No acid orgas in peptone broth from glucose, sucrose, lactose or glycerol Acid from glucose, sucrose, lactose, mannitol and glycerol in peptone-free medium (McCulloch, loc. cit).

Optimum temperature 27°C, Maximum 37°C, Minimum 1° to 3°C, Source Isolated from leaf soot of

begonia.

Habitat Pathogenic on Begonia spp.

Xanthomonas campestris (Pammel) Dowson. (Bacillus competiris Pammel, Iowa Agr. Exp. Sta. Bull. 27, 1895, 1809. Pseudomonas campestris Erw. Smith, Cent. I. Bakt., II Abt., 3, 1807, 284, Bacterium campestris (sec) Chester, Del Col. Agr. Exp. Sta. Ann. Rept., 9, 1807, 110, Phytomonas campestris Hergy et al., Manual, Ist.ed., 1923, 176, Dowson, Cent. I. Bakt., II. Abt., 100, 1929, 190.)
 From L. campestris of the field

Description from McCulloch (Jour-Agr. Res, 58, 1920, 278) Species is probably composed of several varieties. See descriptions by Mckta, Ann Appl. Hol, 12, 1925, 330, Paine and Nirula, Ann Appl. Biol, 15, 1928, 46, Wormuld and Frampton, Ann Rept. Last Mall Res Sta, 1926 and 1927, H Supplement, 1928, 105, and others

Rods 03 to 05 by 0.7 to 20 microns Motile with a polar flagellum Capsules. Gram-negative.

Gelatin Liquefied

Beef agar colonies Wax yellow, round, smooth, shining, translucent, margins entire

Broth Turbed with yellow rim and sometimes a pellicle

Milk Casein digested with the forma-

tion of tyrosine crystals. Alkaline. Natrates not produced from natrates.

Indole formation weak

Hydrogen sulfide produced

Lapolytic (Starr and Burkholder, Phytopath , \$2, 1912, 600)

Artd, no gas, from glucose, sucrose, lactose, glycerol and mannatol. Starch is hydrolyzed.

Optimum temperature 28° to 30°C. Maximum 36°C.

Aerobic.

Distinctivo characters: Causes a vascular infection in cabbage, cauliflower and rutahagas.

Source: Pammel (loc. cit.) first isolated the pathogen from diseased rutabagas.

Habitat: Pathogenic on cabhage, cauliflower and other related species.

9a. Xanthomanas campestris var. armoraciae (McCulloch) Burkholder. (Bacterium campestre var. armoraciae McCulloch, Jour. Agr. Res. 38, 1929, 263; Phytomanas campestris var. armoraciae Bergey et al., Manual, 3rd ed., 1930, 251; Burkholder, Phytopath., 52, 1942, 601) From Gr. Armoracia, the horso radish.

Cultural characters same as Xanthomonas campestris.

Distinctive characters: Causes a leaf spot of horse radish. No vascular in-

fection.
Source: Isolated from diseased horseradish leaves collected in Washington, D. C., Virginia, Connecticut, Iowa and Missouri.

Habitat: Pathogenic on horse radish and related species.

10 Kanthomonas citri (Hasse) Dowson (Pseudomonas citri Hasse, Jour. Agr. Res., 4, 1915, 97; Bacterium citri Doidge, Union So. Africa, Dept Agr. Sci Bul. 8, 1916, 20; Bacilus citri Holland, Jour. Bact., 5, 1920, 218; Phylomonas citri Bergey et al., Manual, 1st ed., 1923, 181; Dowson, Cent. I. Bakt., II. Aht., 100, 1939, 190.) From M. L. Citrus, a genetic name.

Rods: 0 5 to 0 75 by 1.5 to 2 microns, occurring in chains. Motile with a single polar flagellum. Gram-negative.

Gelatin Liquefied.

Beef agar colonics: Appear in 36-48 hours, circular, smooth, raised, dull yellow.

Broth: Turbid in 24 hours. A yellow ring formed. Milk: Casein is precipitated.

Nitrites not produced from nitrates.

Hydrogen sulfide produced (Reid, New Zealand Jour. Sci. and Tech., 22, 1938, 60). Indole not formed.

No gas from glucose, lactose or mannitol.

Starch bydrolyzed (Reid, loc. cit.). Aerobic.

Optimum temperature, 25° to 34°C. Maximum 38°C. Minimum 10°C. (Okabe, Jour. Soc. Trop. Agr., 4, 1932, 476).

Source: Isolated from eanker on orange. Habitat: Produces a eanker on many species of Citrus and related plants.

11. Xantbomonas corylina Miller, Bollen, Simmons, Gross, and Barss. (Miller et al., Phytopath., 89, 1940, 731; Phytomonas corylina Miller et al., tbid.) From Gr. corylus, the bazelnut; M. L. corylina, of the hazel nut.

Rods: 0 5 to 0.7 by 1.1 to 3.8 microns Motile with a polar flagellum. Capsules

Gram-negative.

Gelatin: Liquefaction.

Nutrient glucose-sgar streaks: Abundant growth, filiform, convex, glistening, smooth, opaque, pale lemon yellow, viscid.

Broth: Turbid. Ring formed in 2-5 days.

Milk: Enzymatic curd that is slowly digested. Litmus reduced. Crystsl formation (Burkholder).

Nitrites not produced from nitrates. Nitrogen sources utilized are peptone, aspartic acid, alanine, leucine, sodium ammonium phosphate, allantoin, tyrosine, urie acid and brucine.

Indole is not produced.

Hydrogen sulfide not produced on lead acetate agar. H<sub>2</sub>S produced after Zobell and Feltham's method (Burkholder).

Selenium dioxide reduced.

Lipolytic (Starr and Burkholder, Phytopath., 52, 1942, 600).

Acid, no gas from glucose, fructose, galactose, lactose, sucrose, maltose, xy-lose, raffinose, mannitol, glycerol, and starch. Alkali from salts of citric lactic,

malic and succinic acids. Arabinose, rhamnose, dulcitol, salicin, inulin, and cellulose not utilized.

Starch is hydrolyzed.

Optimum temperature 28° to 32°C. Maximum 37°C. Minimum 5° to 7°C. Thermal death point 53° to 55°C.

pH range for growth. pH 52 to 105. Optimum pH 6 to 8.

Strict aerobe.

Distinctive characters: Cultural characters the same or similar to Xanthomonas juglandis. The two species do not cross-infect.

Source: 26 isolates from widely scattered filbert orchards in Orcgon and Washington.

Habitat: Pathogenic on filberts (Corylus avellana and C. maxima).

12 Xanthomonas cueurbitae (Bryan) Dowson, (Bacterium eucurbitae Bryan, Science, 63, 1926, 165, Bryan, Jour Agr. Res., 40, 1930, 389; Phytomonas cucurbitae Bergey et al., Manual, 3rd cd , 1930, 251: Pseudomonas cucurbitae Stapp, Bot. Rev., 1, 1935, 403; Dowson, Cent. f. Bakt , II Abt., 100, 1939, 190.) From L curcurbita, a gourd, M. L. Cucurbita, a generic name.

Rods: 0.45 to 0.6 by 0.5 to 1.3 microns Motile, usually with a single polar flagellum. Gram-negative.

Gelatin: Liquefied.

Beef-agar slants: Growth moderate, mustard yellow, undulating margins, viscid to butyrous.

Broth: Moderately turbid Ring and yellow sediment.

Milk: Precipitation of casein and digestion. Alkaline.

Nitrites not produced from nitrates Indole not formed.

Hydrogen sulfide produced

Acid from glucose, galactose, fructose, lactose, maltose, sucrose and glycerol. No acid from mannitol

Starch is hydrolyzed. Optimum temperature 25° to 30°C. Maximum 35°C.

Optimum pH 65 to 70. Limits of growth pH 5 S to 9 0. Slight growth in 5 per cent salt.

Source: Species first isolated from

squash. Habitat: Causes a leaf spot of squash and related plants.

13. Xanthomonas dieffenbachiae (Mc-Culloch and Pirone) Dowson, (Phytomonas dieffenbachiae McCulloch and Pirone, Phytopath , 29, 1939, 962; Bacterium dieffenbachige McCulloch and Pirone, thid.; Dowson, Trans. Brit. Mycol. Soc., 26, 1943, 12.) From M. L. Dieffenbachia, a generic name.

Rods. 0 3 to 0 4 by 1.0 to 1 5 microns. Motile with a single polar flagellum. Capsules. Gram-negative.

Gelatin: Liquefied.

Beef-infusion peptone agar colonies: Slow growing, circular, flat, smooth, translucent. Butyrous, Massicot to Naples vellow.

Broth. Turbid. Yellow rim or slight pellicle.

Malk: Slow peptonization and formation of tyrosine crystals. Litmus re-

Nitrites not formed from nitrates Indole not produced.

Hydrogen sulfide produced Acid from glucose, sucrose, lactose,

galactose, fructose and glycerol Growth but no acid in maltose and mannitol. Starch moderately hydrolyzed.

Optimum temperature 30° to 31°C. Maximum 37° to 38°C. Minimum 5°C. Aerobe.

Source: Seven isolates from discased leaves of Dieffenbachia picta.

Habitat: Pathogenic on Dieffenbachia picta. Artificial infection of Dracaena

fragrans.

14. Xanthomonas holcleola (Elliott) Starr and Burkholder. (Bacterium holcicola Elliott, Jour. Agr. Res., 40, 1930, 972; Phytomonas holcicola Bergey et al., Manual, 4th ed., 1934, 271; Pseudomonas Optimum temperature 25° to 30°C. Maximum 36° to 38°C. (Elliott, loc. cit.). Source: Isolated from angular leaf spot

of cotton.

Habitat: Pathogenic on cotton whereever it is grown, causing a leaf spot, a stem lesion and a boll lesion.

19. Xanthomouss pelargonii (Brown) Starr and Burkholder. (Bacterium pelargoni Brown, Jour. Agr. Res., 28, 1923, 372; Pseudomonas pelargoni Stapp, in Soruser, Handb. d. Pflanzenkrank. 2, 5 Aufl., 1923, 181; Phytomonas pelargonii Bergey et al., Manual, 3rd ed., 1939, 250; Starr and Burkholder, Phytopath., 22, 1912, 600.) From Greek, pelargus, the etork; M. L. Pelargonium, a generic name for the etork's hill geranium.

Rods: 0.67 hy 1.02 microns. Capsules. Motile with a polar flagelium. Gram-

negative. Gelatin: Slow liquefaction.

Beef-agar colonies: Cream-colored, glistening, round, with delicate internal markings.

Broth: Turbid in 21 hours. Incom-

plete pellicie.

Milk: Alkaline. Clearing in bands. Nitrates not produced from nitrates Indole formation slight.

Hydrogen sulfide produced. Lipolytic (Starr and Burkholder, Phy-

topath., 52, 1942, 600).

Slight acid but not gas from glucose, sucrose and glycerol.

Starch hydrolysis feebly positive.

Optimum temperature 27°C, Maximum 35°C.

No growth in broth plus 3.5 per cent calt.

Aerobic.

Source: Isolated from spots on leaves of Pelargonium from District of Columbia, Maryland and New Jersey.

Habitat: Pathogenic on Pelargonium spp. and Geranium spp.

20 Xanthomonas phaseoli (Erw. Smith) Dowson. (Bacillus phaseoli Erw. Smith, Bot. Gaz., 24, 1897, 192; A. A. A. S. Proc., 49, 1898, 288; Pseudomönas phaseoli Erw. Smith, U. S. Dept. Agr., Div. Veg. Phys. and Path., Bul. 25, 1901, 1; Bacterium phaseoli Erw. Smith, Bact. in Rel. to Plant Dis., 1, 1905, 72; Phytomonas phaseoli Bergey et al., Manual, 1st ed., 1923, 177; Dowson, Cent. f. Bakt., II Aht., 100, 1939, 190.) From Gr. phaseolus, the bean; M. L. Phaseolus, a generic name.

Description from Burkholder, Cornell Agr. Exp. Sta. Mem. 127, 1930, 18;

and Phytopath., 22, 1932, 609., Rods: 0.87 by 1.0 microns. Motile with a polar flagellum. Gram-negative. Gelatin: Liquefaction.

Beef-extract ngar colonies: Circular, amber yellow, smooth, hutyrous, edges entire.

Broth: Turbid in 24 hours, Vellow

Broth: Turbid in 24 hours. Yellow ring.

Milk: Casein precipitated and digested. Alkaline. Tyrosino crystals formed. Nitrites not produced from nitrates.

Indole not formed.

Hydrogen sulfido produced.

Lipolytic (Starr and Burkholder, Phytopath., 52, 1942, 600).

Acid but not gas from glucose, galactose, fructose, arabinose, xylose, maltose, lactose, sucrose, raffinose and glycerol. Alkaline reaction from salts of acetic, malte, citric and succinic acids. Mannitol, dulcitol, salicin and formic and tartaric acids not fermented.

Stareb is hydrolyzed.

Aerobic.

Very slight growth in beef broth plus 4 per cent salt (Hedges, Jour. Agr. Res., 29, 1924, 243).

Distinctive character: Similar in culture to Xanthomonas campestris, X. juglandis, X. vesicatoria, etc., but they do not cross infect.

Habitat: Pathogenic on the bean (Phateolus vulgaris), the hyacinth bean (Dolichos lablab), the lupine (Lupinus polyphillus), etc. Not pathogenic on the soy bean (Glycine sp.), nor cowpea (Vigna sp.).

20a. Xanthomonas phaseoli var sojensis (Hedges) Starr and Burkholder. (Becterium phascoli var. soiense Hedges. Science, 50, 1922, 11, Jour. Agr Res, 29, 1921, 229; Phytomonas phaseoli var. sojense Burkholder, Phytonath . 20. 1930, 7; Starr and Burkholder, Phytopath., 32, 1912, 600 ) From M L the soy bean, Soja, a generic name, M L sojensis, of the soybean

Synonyms: Pseudomonas glycines Nakano, Jour. Plant Protect Tokyo, 6, 1919, 39 (Bacterium glyeines Elliott, Manual Bact, Plant Path., 1928, 133, Phytomonas glycines Magrou, in Hauduroy et al, Dict. d. Bact. Path., 1937, 358) Takimoto, Jour. Plant Protect Tokyo, 18, 1931, 29; and Olabe, Jour Trop Agr. Formasa, 4, 1932, 473 )

Distinctive character. Differs from Xanthomonas phaseoli in that it infects the soy bean, Glycine maz.

Source: Isolated from pustules on the leaves and pods of soy bean, both in America and in Japan.

Habitat: Pathogenic on the soy bean, Glycine max and the common bean, Phaseolus vulgaris.

20h. Xanthomonas phaseoli var fuscons (Burkholder) Starr and Burkholder (Phytomonas phaseoli var fuscans Burkholder, Cornell Agr. Evp. Sta Mem 126, 1930, 22; Phytopath . 22, 1932, 699, Bactersum phascols var. fuscans Okabe, Jour. Soc. Trop. Agr. Formosa, 5, 1933, 161; Pseudomonas phaseoli var fuscans Stapp, Bot. Rev., 1, 1935, 407; Starr and Burkholder, Phytopath , 33, 1942, 600 ) From L. fuscans, producing a beown color.

Distinctive characters: Differs from Xanthomonas phaseoli in that it produces a deep brown color in beel-extract-peptone media and in tyrosine media. Action on maltose negative or feeble.

Source: Two cultures isolated; one from a diseased bean leaf (1924) and a diseased pod (1927) collected in Switzerland.

Habitat: Pathogenic on beans, Phaseolus sulgaris, and related plants.

21. Xanthomonas plantaginis (Thornberry and Anderson) comb. nov. (Phytamonas plantaginus Thornberry and Anderson, Phytopath., 27, 1937, 947.) From Latin, Plantago (-aginis), plantain; M. L. Plantago, a generic name.

Rods: 0 6 to 1.0 by 1.0 to 1.8 microns. Occurring singly or in chains. Capsules. Motile with 1 to 2 polar flagella, Gramnegative.

Gelatin: Slight liquefaction.

Glucose agar slant; Growth moderate. filiform, raised, opaque, yellow and viscid.

Broth Moderately turbid with ring. Milk: Slight acidity, no reduction of

litmus. Peptonization. Nitrites not produced from nitrates.

Indole not formed

Hydrogen sulfide not produced.

No appreciable amount of gas from carbobydrates.

Starch is hydrolyzed

Optimum temperature 25°C, Minimum 12°C Maximum 35°C. Thermal death point 50°C.

Aerobic

Source From diseased leaves of Plantago lanceolata in Illinois.

Habitat · Pathogenic on Plantage spp.

22. Xanthomonas ricinicola (Elliott) Dowson (Bactersum recini Yoshi and Takimote, Jour. Plant Protect. Tokyo. 15, 1923, 12, Bacterium ricinicola Elhott, Man Bact Plant Path , 1930, 193; Phytomonas ricinicola Burkholder, in Manual. 5th ed , 1939, 152; Dowson, Cent. f. Bakt., II Abt , 100, 1939, 190, Xanthamonas ricini Dowson, ibid.) From L. living on the castor bean, M. L. Ricinus. a generic name.

Rods : 0 4 to 0 9 by 1.3 to 26 microns. Capsules. Short chains. Motile with polar flagella. Gram-negative

Gelatin: Liquelaction.

Nutrient agar colonies: Lemon vellow. changing to brown.

162

Milk: Slightly acid. No coagulation. Peptonization.

Nitrites not produced from nitrates. Acid but not gas from lactose.

Starcb hydrolyzed.

Optimum temperature 29° to 30°C. Maximum 39°C. Minimum 2.5°C.

Aerobie.

Source: Isolated from leaf-snot of rastor-bean.

Habitat: Pathogenic on Ricinus communis.

23a. Xanthomonas translucens f. sp. hordei Hagborg. (Canadian Jour. of Res., 20, 1942, 317.) From L. translucens, shining through, translucent, referring to the character of the lesion produced by this pathogen. Form name from Hordeum, a generic name.

Synonyms: Bacterium translucens Jones, Johnson and Reddy, Jour. Agr. Res., 11, 1917, 637; Pseudomonas translucens, sbid.; Phytomonas translucens Bergey et al, Manual, 3rd ed., 1930, 252; Xanthomonas translucens Dowson, Cent. Bakt., II Abt , 100, 1989, 190.

Rods: 05 to 08 by 1 to 2.5 microns. Motilo with a single polar flagellum.

Gram-negative.

Celatin: Liquefaction

Beef-peptone agar colonies: Round. smooth, shining, amorphous except for inconspicuous somewhat irregular concentric strictions within, wax-yellow tinged with old gold; margin entire.

Broth: Turbidity becomes rather

strong. Pellicle.

Milk: Soft coagulum and digestion. Milk clears Tyrosine crystals produced. Nitrites not produced from nitrates.

Indole: Slight formation. Hydrogen sulfide produced.

Lipolytic (Starr and Burkbolder, Phytopath , 52, 1942, 600)

Ammonia from peptone.

Acid but not gas from glucose, dfructose, d-mannose, d-galactose, sucrose, lactose, and sometimes salicin. No utilization of 1-rhamnose, inositol, maltose, raffinose, inulin, d-mannitol, and dul-

Starch hydrolyzed.

Optimum temperature 26°C, Maximum 36°C. Minimum 6°C. Aerobic.

Distinctive characters: All forms of Xanthomonas translucens have the same cultural characters. They differ mainly in pathogenicity. This form is pathogenic on harley, Hordeum spp.; but not on oats, Avena spp., Tye, Secale cereale nor on wheat, Triticum spp.

Source: Isolated from leaves and seed of barley. Hordeum vulgare.

Habitat: Occurs naturally on barley.

 Xanthomonas translucens f. sp. undulosa (Smith, Jones and Reddy) Hagborg. (Bacterium translucens var. undulosum Smith, Jones and Reddy, Science, 50, 1919, 48; Pseudomonas translucens var. undulosa Stapp, in Sorauer, Handb. d. Pflanzenk., 2, 5 Auf., 1928, 17; Phylomonas translucens var. undulosa Hagborg, Canadian Jour. Res., 14, 1936, 347; Hagborg, Canadian Jour. Res., 20, 1942, 317.) From L. unda; M.L. undulosus, undulate, referring to the undulation of the colony.

Distinctive characters: Cultural characters same as all forms of Xanthomonas translucens. Pathogenic on wheat, Triticium spp., barley, Hordeum spp. and rye, Secale cereale but not on oats, Avena spp.

Source: Isolated repeatedly from black chaff of wheat.

Habitat: Usually found on wheat causing the black chaff, and on rye.

23c. Xanthomonas translucens f. sp. secatis (Reddy, Godkin and Johnson) Hagborg. (Bacterium translucens var. secalis Reddy, Godkin and Johnson, Jour. Agr. Res., 28, 1924, 1039; Pseudomona translucens var. secalis Stapp, in Soraucr, Handb. d. Pflanzenkr., 2, 5 Aufl., 1928, 24; Phytomonas translucens var. secales Burkholder, in Manual, 5th ed., 1939, 160; Hagborg, Canadian Jour.

Res., 20, 1942, 317.) From M.L. Secale, a generic name. Distinctive characters Cultural characters same as other forms of Xanthomonas translucens. This form pathogenic on tvc Secale cercale, but not on Triticum spp., Hordeum spp. nor Avena spp.

Source: Isolated from leaf spot on rye, Secale cereale.

Habitat: Pathogenic on ryc.

23d. Xanthomonas translucens f. sp hordei-arenae Hagborg (Canadian Jour Res , 20, 1942, 317.) From M L Hordeum and Avena, generic names.

Distinctive characters Cultural charneters same as other forms of Xanthomonas translucens. Pathogenic on barley, Hordeum spp and oats, Atena spp, but not on wheat. Triticium spp . nor rye, Secale cereale.

Source: Isolated 6 times from barley at various places in Canada

Habitat: Occurs naturally on barley

23e. Xanthomonas translucens f sp cerealis Hagborg. (Canadian Jour Res , 20, 1942, 317.) From L., of cereal.

Distinctive characters; Cultural characters same as other forms of Xanthomonas translucens. Pathogenic on wheat, Triticum spp.; oats. Avena spp.; barley, Hordeum spp.; and rve, Secale cereale

Source: Isolated from wheat in Canada. Habitat: Occurs naturally on wheat.

24. Xanthomonas vasculorum (Cobb) Dowson. (Bacillus vascularum (sic) Cobb, Agr. Gaz. of New South Wales, 4, 1893,777; Abst. in Cent f. Bakt., II Abt , 1, 1895, 41; Bacterium vascularum Migula, Syst. d. Bakt., 2, 1900, 512, Pseudomonas vascularum Erw. Smith, U S. Dept Agr , Div. Veg. Phys and Path , Bul 28, 1901, 153; Phytomonas vascularum Bergey et al., Manual, 1st ed , 1923, 179; Dowson, Cent. f. Bakt., II Abt , 100, 1939, 190.) From L vasculum, a small vessel; M. L. the vascular system.

Note: Erw. Smith (Bact. in Rel. to

Plant Dis., S, 1914, 88) states that probnbly Spegazzini (El Polville de la Cana de Azucar, June, 1895, La Plata, Supl. Rev. Azuc., Buenos Aires, No 16, 1895) reported the disease caused by Xanthomonas casculorum but that Bocillus sacchar: Spegazzini which he claimed to be the pathogen, was a saprophyte

Description from Smith (loc. cit., 54). Rods: 0.4 by 1.0 microns Motile with a polar flagellum. Gram-variable.

Gelatin: Liquefaction feeble. Liquefaction good (Burkholder).

Beef-extractagar colonics Pale yellow, smooth, glistening, not noticeably viscid, Broth. Cood growth.

Milk: Alkaline Natrates not produced from nitrates. Lapolytie (Starr and Burkholder, Phy-

topath , 52, 1942, 600). Acid but not gas from glucose, fruetose and glycerol.

Starch hydrolyzed (Burkbolder).

Optimum temperature 30°C. Maximum 35° to 37.5°C (Elliott, loc cit ),

Habitat, Pathogenic on sugar cane, Sacchorum officinorum, causing a bacterial cummosis.

25 Xanthomonas vesicatoria (Doidge) Dowson. (Bacterium restcatorium Doidge, Jour Dept Agr , S Africa, 1. 1920, 718, niso Ann Appi, Biol , 7, 1921, 428, Pseudomonas resicatoria Stapp, in Sorauer, Handb d Pflanzenkrank., 2, 5 Aufl., 1928, 259, Phytomonas resicatoria Bergey et al , Manual, 3rd ed , 1930, 253; Donson, Cent f Bakt, II Abt., 100, 1939, 190 ) From L. resica, a blister; M. L. resteutorius, causing blisters.

Synonyms: Gardner and Kendrick (Phytonath , 15, 1923, 307) list Pseudomonas exitiosa Gardner and Kendnek (Phytopath , 11, 1921, 55; Bacterium exitionum Gardner and Kendrick, Jour. Agr. Res., 21, 1921, 141; Phytomonos exitiosa Bergey et al., Manual, 1st ed., 1923, 183) and an unnamed species, Higgins (Phytopath, 12, 1922, 513). Rods: 06 to 07 by 10 to 1.5 microns

Motile with n polar flagellum. Capsules. Gram-positive. Gram-negativn (Gnrd-ner and Kendrick; and Higgins).

Gelatin: Liquefaction.

Nutrient agar colonies: Good growth. Circular, wet-sbining, Naples yellow, edges entire.

Milk: Cascin precipitated and slawly digested. Tyrosine erystals.

Nitrites not produced from nitrates.
Indole not formed.

Hydrogen sulfido produced (Burkh.der).

Lipolytic (Starr and Burkholder, Phytopath, 52, 1942, 600).

Acid but not gas from glucose, fructose, sucrose, lactose, galactose, glycerol and dextrin.

and dextrin.

Certain strains hydrolyze starch, nthers
do not (Burkholder and Li, Phytopath...

\$1, 1941, 753).

Optimum temperature 30°C.

Source: Isolated from spotted tomato fruits in South Africa.

Habitat: Pathogen an tomatocs, Lycopersicon esculentum and peppers, Capsicum annuum.

25a. Xanthomonas vesicaloria var. raphani (White) Starr and Burkholder. (Bacterium resicaloria var. raphani White, Phytopath, 20, 1930, 653; Phytomonas vesicaloria var. raphani Burkholder, in Manual, 5th ed, 1939, 154; Starr and Burkholder, Phytopath., 52, 1942, 600.) From M. L. Raphanus, the radsh, a generic name.

Distinctive characters: Cultuml characters similar to Xanthomonas vesicatoria, but differs in that it is able ta attack radishes, turnips, and ather crucifers. Differs from Xanthomonas campestris in that it does not cause a vascular disease, and differs from Xanthomonas campestris var. armoraciae in that it is not pathagenic na horscradish.

Source: Isolated from leaf spots of radish and turnips in Indiana.

Hahitat: Pathogenic on radish, turnips, and other crucifers; and on tomato and pepper.

26. Xanthomons nakatae (Okahe) Dowson. (Bacterium nakatae Type B, Okabe, Jun. Soc. Trop. Agr., Formosa, 5, 1933, 161; Phytomonas nakatae Burkhalder, in Manual, 5th ed., 1939, 154; Dowson, Trans. Brit. Mycol. Soc., 26, 1943, 12.) Named for Nakata, the Japanese plant pathologist.

Rnds: 0.3 tn 0.4 by 1.1 to 2.5 microns. Capsules. Motile with n polar flagellum.

Gram-negative.

Gelatin: Liquefaction. Brown color. Beef-extract agar colonics: Amber yellow, round, smooth, glistening, margins entire. Brown.

Broth : Moderate turbidity with yellow

ring. Medium turns brown.

Milk: Cascin is precipitated and digested. Tyrosino crystals. Brown color. Nitrites not produced from nitrates. Indole not formed.

Slight amount Il.S produced.

Acid but not gas from glucose, sucrose, maltose and lactose.

Starch: Strong diastatic netion.

Optimum temperature 30° tn 32°C. Maximum 30°C. Minimum 10°C.

No growth in beef extract broth plus
2 per cent salt.

Aerobic.

Distinctive character: Differs from Type A in that it produces a brown pigment in culture. (Description of Type A ant seen.)

Source: Isolated from water-soaked to brown leaf spots on jute.

Habitat: Pathogenic on jute, Corchorus cansularis.

27. Kanthomonss papaverfeola (Bryan and McWhorter) Dowson. (Bacterium papawericola Bryan and McWhorter, Jour. Agr. Res., 40, 1930, 9; Phytomonas paparericola Bergey et al., Manual, 4th ed., 1931, 265; Dowson, Cent. f. Bakt., II Abt., 100, 1939, 190.) From L. papaver, poppy; -cola, dweller; M. L. Papaver, a generio name.

Rods: 0.6 to 0.7 by 1 to 1.7 microns. Chains. Capsules. Motile with a single polar flagellum. Gram-negative. Gelatin: Liquefaction.

Beef agar colonies: Mustard yellow to primuline yellow, circular, margins entire.

Broth: Turbidity prompt with a yellow ring and an incomplete pellicle.

Milk: Soft coagulation, peptonization and production of tyrosine crystals Nitrates: A weak reaction for nitrites

after 10 days.

Indole not formed.

Hydrogen sulfide is produced. Lipolytic (Starr and Burkholder, Phytopath., 52, 1942, 600).

Acid but not gas from glucose, galactose, fructose, aucrose, lactose, maltose, glycerol and mannitol.

Starch is hydrolyzed

Optimum temperature 25° to 30°C. Maximum 35°C.

No growth in broth plus 5 per cent sait. Acrobic.

Source: Isolated from black spots on

leaves, buds and pods of poppy Habitat : Pathogenic on poppy, Paparer rhoeas.

28. Xanthomonas alfalfae (Riker et sl.) Dowson. (Baclersum alfalfae Riker, Jones and Davis, Jour. Agr Res , 51, 1935, 177; Phytomonas alfalfae Riber et al., ibid.; Pseudomonas alfalfae Riker et al., ibid ; Dowson, Trans Brit Mycol Soc., 26, 1943, 11.) From Spanish, of alfalfa.

Rods: 0.45 by 2.4 microns. Motile with a polar flagellum. Gram-negative.

Gelatin: Liquefied. Nutrient agar stroke: Growth abun-

dant, filiform, smooth, glistening, butyrous, pale rellow. Broth: Turbid in 21 hours. Light

sediment. Milk: Casein is precipitated and di-

gested. Ammonia formed alowly in a nitrate

medium. Carbohydrates: No seid in yeast broth plus sugare.

Starch is hydrolyzed

Aerobic.

Optimum temperature 24° to 32°C. Maximum below 36°C. Minimum below

Source: Six single cell cultures isolated from diseased alfalfa.

Habitat: Pathogenic on the leaves of nlinlia, Medicago sativa.

29. Xanthomouss acernea (Ogawa) comb. nov. (Pseudomonas acernea Ogawa,

Ann. Phyt. Soc. Japan, 7, 1937, 123; Phytomonas acernea Ark, Phytopath., 29, 1939, 968.) From L. acerneus, of the maple. Rods: 0.2 to 0.6 by 0.5 to 1.2 microns.

Motsle with one polar flagellum. Gramnegative.

Gelatin: Liquified.

Agar colonies. Round, smooth, convex, white to citron yellow, glistening, translucent with smorphous structure,

Broth : Turbid. Milk - Slowly cleared, slightly acid.

No coagulation. Natrates produced from nitrates.

Hydrogen sulfide produced. No gas produced in peptone water plus sugars.

Starch not hydrolyzed

Optimum temperature about 32°C. Thermal death point 59°C. Arrobin.

Source · From diseased leaves of Acer trifidum in Japan.

Habitat: Causes a disease in Acer spp. and in Acsculus turbinate and Koelrenterra paniculata

30 Kanthomonas estotae (Kendrick) Dowson. (Phytomonas carolae Kendrick, Jour. Agr. Res , 49, 1931, 501; Pseudomonas carotas Kendrick, ibid .: Donson, Cent f. Balt., II Abt., 100,

1939, 190 ) From L. carola, the carrot. Rods: 042 to 0.85 by 138 to 275 mierons. Motile with 1 or 2 polar flagella.

Gram-necative. Gelatin : Liquelied.

Potato glucose agar: Colonies round, smooth, glistening, margins entire, straw yellow in color,

Milk: Gasein precipitated and milk eleared; alkaline.

Nitrites not produced from nitrates.

Indole not formed.

Acid, no gas, from glueose, d-galactose, xylose, d-mannose, l-arabinose, sucrose, lactose, raffinose, trehalose, d-mannitol and giveerol No acid from maltose and rharonose.

Starch not hydrolyzed.

Optiroum temperature 25° to 30°G. Tolerates 4 per cent salt at pH 7

Aerobic.

Source Two original isolations from diseased carrots and a reisolation from inoculated carrots were used for the description.

Habitat. Pathogenic on leaves of Doucus carota var satura.

31. Xanthomonas hederae (Arnaud) Dowson (Bacterium hederae Arnaud, Gompt. rend Acad Sci., Paris, 171, 1920, 121; Phytomonas hederae Burkholder and Guterman, Phytopath , 22, 1932, 783, Dowson, Cent. f. Bakt, II Aht., 100, 1939, 190 ) From L hedera, ivv; M L. Hedera, n generic name.

Description taken from Burkholder and Guterman (loc. cit.).

Rods: 06 by 213 microns. Motile with a single polar flagellum. Gramnegative.

Gelatin: Liquefied

Beef-extract-agar slants · Growth good, filiforro, amber yellow, hutyrous.

Broth: Turbid. Milk: Casein is precipitated and digested. Milk becomes alkaline.

Nitrites not produced from nitrates. Hydrogen sulfide is formed.

Indole not formed.

Not hpolytic (Starr and Burkholder,

Phytopath , 32, 1942, 600)

Acid from glucose, fructose, galactose, xylose, sucrose, lactose and glycerol. Alkalı from salts of acetie, estric, lactie, malie and succinic acids The following are not utilized arabinose, rhamnose, maltose, salicin, starch, cellulose and formie acid.

Aerobic, Iacultative.

Source: Isolated from diseased ivy leaves.

Habitat: Pathogenie on ivy, Hedera helix.

32. Xanthomonas phormicola (Takimoto) Dowson (Bacterium phormicola Takimoto, Jour. Plant Protect., 20, 1933, 777; Phytomonas phormicola Burkholder, in Manual, 5th ed., 1939, 159; Dowson, Trans. Brit. Mycol, Soc., 26, 1943, 12.) From M. L. Phormium, a generic name.

Description translated by Dr. K.

Togashi.

Rods: 0.5 to 06 by 1 to 2 microns Motile, with a single flagellum. Gramnegative.

Gelatin: Liquefied.

Agar colonies: Light yellow, then wavy yellow; butyrous, then viscid.

Broth: Turbid, pellicle formed.

Milk: Gascin coagulated slowly and precipitated, then digested. Alkaline.

Nitrites not produced from nitrates. Indole not formed

Hydrogen sulfide produced.

No gas from sucrose, glucose, lactose and glycerol.

No acid from various sugars in broth. Optimura temperature about 29°C Maximum 39°G. Minimum about 0°C.

Aerobic. Source: Species isolated from New

Zealand flax, Phormium tenax. Habitat: Causes a leaf stripe of Phormittm tenax.

33 Xanthomonas geranli (Burkholder) Dowson. (Phytomonas geranii Burkholder, Phytopath , 27, 1937, 560; Dowson, Cent. f. Bakt., II Abt., 100, 1939, 190) Froro Greek, geranos, crane; M. L. Geranium, n generie name.

Rods 075 to 20 microns. Motile with a single polar flagellum. Gramnegative

Gelatin: Liquefied.

Beef-extract agar slants: Moderate to good filiform growth, glistening, primuline yellow. Develops in 24 hours.

Broth: Turbid in 24 hours. No pellicle but a moderate sediment.

Milk: Becomes clear with a heavy easein precipitate. Peptonization with crystal formation.

Nitrates reduced to ammonia

Indole not formed.

Hydrogen sulfide formed

Lipolytic (Starr and Burkholder, Phytopath., \$2, 1942, 600).

Acid from glucose, galactose, fructose, xylose, rhamnose, lactose, sucrose, raffinose and glycerol. Alkaline reaction from salts of citric, male, malome and succinic acid. No growth in ambinose or formic, hippuric, malere or tartane neid.

Starch not hydrolyzed

Aembe

Distinctive characters Pathogenic on Geranium app., not on the house geranium, Pelarganium hortorum In euliure similar to Xanthomonas pelargons:

Source: Three cultures isolated from

Geranium zanguineum Habitat : Pathogenic on Geranium san guineum, G. maculatum, G protense and G. sylvaticum.

Xanthomones entirrhini (Tak: moto) Donson, (Pseudominas antirrhini Takimoto, Bot Mag Tukyo, 54, 1920, 257; Boetersum antirrhins I fliott, Man. Bact. Plant Path , 1930, 93, Phylo monus antirrhini Magrou, in Hauduroy et al., Diet. d beet path , Paris, 1937, 331; Douson, Trans Brit Mycol Foe . 26, 1913, 11.) I'rom Gr antierhinum, snapdragon: M L Antierhinum, a generic name.

Description from I thatt (loc est )

Rods: 0.3 to 0.4 by 0.5 to 1.2 microns Motile with polar flagella Capsules Gram-negative

Gelatin: Liquefied

Arret. colonies Round, ghetenire, white, later yellow

Milk: Congulated and even digered Nitrites are produced from natrates No gra produced Acrobic.

Optimum temperature 26° to 27°C. Maximum 34°C.

Habitat: Causes a leaf spot of Antirrhinum majus.

35. Xanthomonas heterocea (Vzoroff) comb, nor. (Phytomonas heterocca Vzoroff, Bull. North Caucasian Plant Prot. Sts. Roztoff-on-Don, 6-7, 1930, 263; Bacterium heteroceum Burgwitz, Phytopathogenic bacteria, Lenngrad, 1935. 135 ) From Gr. heterus, another, different.

Description taken from Rev. App. Mye . 10, 1931, 628

Rods. 04 to 06 by 10 to 20 microns. Motile Gram-negative.

Gelatin Slow liquefaction.

Agar colonies: Round, convey, smooth, semi-transparent, glistening, yellow to amber, 2 mm in diameter. Pitted sur-Lice.

Milk No congulation. At first acid, later alkaling.

Natrates produced from natrates

Indole not formed

Hydrogen sulfide produced.

tend from glucose, gulaciose, arabinose, vylose, sucrose, maltose, salicin. glycerol and mannitol Does not ferment lictore, mulin, ethyl alcohol, esculin, adonitol or delected

Optimum temperature 25° to 30°C. Source Isolated from diseased tobacco

in the North Caucasus Habitat · Pathogenic on Nicoliana tobecum

36 Xanthomonas gummisudans (Me-Culloch) Starr and Hurkholder, (Racterium gummientans McCulloch, Phytopath . 14, 1921, 63, also Jour. Agr. Hes . 27, 1921, 221; Pseudamonas gummisudans Stapp, in Sorager, Handb, d. Pflancenkrank . 2, 5 Aufl , 1828, 51; Phylomonas cummisudant Bergey et al., Manual, 2nd ed , 1925, 201; Starr and Burkholder, Phytopath , 52, 1912, 669 ) From I. guerre, grine; endans, enenting, dripperg Hole: 06 to 0.5 by 1 to 25 microns

Capsules. Motile with a polar flagellum. Cram-negative.

Celatin: Liquefied.

Beef-peptone agar colonies: Amber yellow, circular, transparent, smooth, with definite margins.

Broth: Moderately turbid with a yellow ring.

Milk: Soft eurd which is digested with formation of tyrosine crystals.

Nitrites not produced from nitrates.

Indole not produced. Hydrogen sulfide produced.

Lipolytic (Starr and Burkholder, loc. cit.).

Acid from glucose and sucrose.

Optimum temperature 30°C. Maximum 36°C. Minimum 2°C.

Aerobic.

Source: From gummy lesions on gladiolus leaves.

Habitat: Pathogenic on leaves of gladioli.

37. Xanthomonas lactucae (Yamamoto) Dorson. (Bacterium lactucae Yamamoto, Jour. Plant Protect., 21, 1934, 532; Phytomonas lactucae Bergey et al., Manual, 5th ed., 1939, 163; Dowson, Trans. Brit. Mycol. Soc., 26, 1943. 12.) From L. lactuca, lettuce; M. L. Lactuca, a generic name.

Description translated by Dr. K Togashi.

Rods: 0 6 to 0.8 hy 1.75 to 2.8 microns. Motile with a polar flagellum. Gramnegative.

Gelatin: Liquefaction slow.

Agar colonies: Circular, convex, margin entire, surface smooth, wet-shining, vellow.

Broth. Turbid. Ring and pellicle Milk: Slow peptonization.

Nitrites not produced from nitrates. Indole not produced.

Hydrogen sulfide produced.

Acid, no gas, from glucose, sncrose, and lactose in bouillon; no acid from glycerol in bouillon.

Optimum temperature 28°C. Maximum 35°C. Minimum helow 2°C.

Aerobic.

Source: Isolated from leaf spot of lettuce.

Habitat: Pathogenie on leaves of asparagus lettuce, Lactuca satira var. angustata.

33. Xanthomonas nigromaculans (Takimoto) Dowson. (Bacterium nigromaculans Takimoto, Jour. Plant Protect, Tokyo, 14, 1927, 522; Phytomonas nigromaculans Magrou, in Hauduroy et al., Diet. d. Bact. Path., Paris, 1937, 357; Dowson, Trans. Brit. Mycol. Soc., 26, 1943, 12.) From L. niger, black; maculans, spotting.

Description translated by Dr. K. Togashi.

Rods: 0.6 to 0.9 hy 1.5 to 2.8 microns. Motile with 1 or 2 polar flagella. Cramnegative.

Gelatin: Liquefaction.

Agar colonies: Yellow, circular, margins entire, smooth, glistening.

Broth: Growth moderate with yellow pellicle.

Milk: Congulation and digestion of the cascin.

Nitrites not produced from nitrates.

Indole not produced.

No acid or gas from glucose, sucrose, lactose, mannitol and glycerol in peptone water.

water.
Optimum temperature 27° to 28°C.
Maximum 33°C. Minimum 0°C.

Aerohic.

Source: Isolated from lesions on leaf and petioles of hurdock.

Hahitat: Pathogenic on leaves and petioles of Arctium lappa, the hurdock.

39. Xanthomonas oryzae (Uyeda and Ishiyama) Dowson. (Pseudomonas oryzne Uyeda and Ishiyama, Proc. Third Pan-Pacific Sci. Congr., Tokyo, 9, 1926, 2112; Bacterium oryzae Nakata, see Elliott, Man. Bact. Plant Path., 1930, 172; Phytomonas oryzae Magrou, in Hauduroy et al., Dict. d. Bact. Path. Paris, 1937, 383; Dowson, Trans. Brit.

Mycol. Soc., 26, 1943, 12.) From Gr. oryza, rice; M. L. Oryza, a generic name

Probable synonym: Pseudomonas itoana Tochinai, Ann. Phytopath Soc Japan, 2, 1932, 450; Bacterium stoanum Burgwitz, Phytopathogenic Bacteria, Leningrad, 1935, 74; Phytomonas stoana Magrou, in Hauduroy et al., Diet. d. Bact. Path., Paris. 1937, 370

Rods: 05 to 08 by 10 to 20 microns-Motile with a polar flagellum Cram-

negative.

Gelatin: No liquefaction.

Nutrient agar colonies Round, smooth, glistening, wax vellow.

Milk: Slightly acid.

Nitrites are not produced from nitrates. Hydrogen sulfide produced.

Acid but no gas from glucose, lactose and success.

Optimum temperature 26° to 30°C.

Strict aerobe. Source: Isolated from a less blight of

Habitat: Pathogenic on rice, Oryzo

40. Kanthomonas celebenais (Gšumann) Dowson, (Pesudomonas celebensis Gšumann, Ztscbr. f. Planenkrank, 35, 1923, 11; Meded Inst. voor Plantentek, Bulienorg, 59, 1923, 17; Bacterum celebenae Elhott, Man Bact. Plant Patb., 1920, 193; Phylomonas celebenas Magrou, in Hauduroy et al., Dict. d. Bact. Path. Paris, 1937, 433; Dowson, Trans. Brit Mycol Soc., 26, 1943, 11.) From M. L of the island Celebes.

Rods: 0 9 by 1.5 microns Motile by a polar flagellum. Gram-negative.

Agar colonies: Grayish yellow.

Broth: Thin pellicle.

Milk: Coagulated and cleared. Nitrites not produced from nitrates.

Sodium selenite: Brick red

Starch is hydrolyzed.

Source: From vascular bundles of diseased bananas in Celebes.

Habitat: Causes the blood disease of banana,

41. Xanthomonas panici (Elliott), comb. nos. (Racterium panic Elliott, Jour. Agr. Res., 26, 1923, 157; Pseudomonas panici Stapp, in Sorauer, Handb. d. Pflanzenkank, s, 5 Aufl, 1928, 27; Phyloromona panici Bergey et al., Manual, 3rd ed., 1930, 229 ) From M. L. Panicum, a generic name.

Rods: 0 69 by 1 66 microns. Capsules. Motile by 1 or rarely 2 polar flagella. Gram-megative.

Gelatin: Liquefaction slow.

Beef agar colonies: Round, white, amouth, glistening, margins at first entire, later undulate.

Broth: Moderate turbidity in 24 hours. Thin pellicle. Medium brownish,

Milk: Alkaline and clears.

Nitrites are produced from nitrates

Indole not produced.

Hydrogen sulfide produced. No gas from carbohydrates.

Starch: Hydrolysis moderate

Optimum temperature 33°C, Maximum 45°C. Minimum 5°C

Optimum pH 6.15 to 6.3. pH range 54 to 10 0.

Aerobic

Distinctive characters Differs from Pseudomonas andropogoni in that it liquefies gelatin, produces piltrates from mitmies, and does not infect sorghum and broom corn. Source Isolation from water soaked

lesions on leaves, sheaths and culms of millet collected in Wisconsin and in S. Dakota

Habitat Pathogenic on proso millet, Panicum miliaceum.

42. Kanthomonas proteamaculans (Paine and Stansfield) comb. nov. (Peeudomons proteamaculans Faine and Stansfield, Ann. Appl. Biol., 6, 1919, 38; Phylomoras proteamaculans Bergey et al, Manual, 3rd ed., 1930, 247, Bacterum proteamaculans Elliott, Man. Bact. Plant Path., 1930, 185.) From M. L. Protea, a sencire mane; maculans, spotting.

Rods: 0 6 to 0.8 by 0.8 to 1.6 microns

Motile with 1 to 3 polar flagella. Grampositive.

Gelatin: Liquefaction.

Agar slant : Growth wet-shining, dirty white with a faint yellow times.

Broth: Turbid in 2t hours, Slight ring.

Milk : Acid with soft curd after 2 days. Later a separation of whey,

Nitrites are produced from nitrates. Acid and gas from glucose, sucrose and mannitol. No neid or gas from lactose.

Starch: Slight hydrolysis. Source : Repeated isolation from a leafspot of Proten in England.

Habitat: Pathogenic on Proten eynaroides.

43. Xanthomonas manihotis (Arthaud-Berthet) comb. nor. (Bacillus manihotus Arthaud-Berthet by Bondar, Chacaras and Quintaes 5(4), 1912, 15; Baeillus manihot Bondar (and Arthaud-Berthet). Bal. Agric., São Paulo, 16, 1915, 513; Bacterium manihotus Drummond and Hipolita, Ceres, 2, 1911, 298; Phytomonas manihotis Viceas, Rev. d Agr., Pieracicaba, 15, 1910, 475 ) From M. L. Maniholus, a generic name

Description from Burkholder, Phytopath., 52, 1912, 147

Rods: 0 35 ta 0 93 by 1.4 to 2.5 microns. Gram-negative and mostly non-motile. One isolate showed a few cells with 1 polar flagellum Amaral (Instit. Biol., São Paulo, Arg., 15, 19t2, 120) states that the species is motile with one polar flagellum.

Gelatin: Liquefaction.

Beef-extract-peptone agar: raised, ivory-color, smooth, shiny, with edges entire.

Potato-glucose agar: Growth abundant, white to hyaline, very mucaid. Broth: Turbid with a whitish granular ring.

Litmus milk: Litmus reduced and milk elears. With return of color, litmus is purple.

Indole not formed.

Hydrogen sulfide is formed

Nitrites produced from nitrates (Drammond and Hipolito, loc. cit.).

Asparagine not used as a nitrogen and carbon source. No growth in nitrate synthetic broth.

Weak growth but slight neid production in synthetic medium plus glurose. d-galactore, d-fruetose, d-xylose, maltose and sucrose. No growth in rhamnose, 1-prabinose, d-lactose, glycerol, mannitol and salicin. Good growth with alkaline reaction in same medium plus salts of the following acids: acetic, citric, malic, maleic and succinic. The salts of formic, hippuric, lactic and tartaric acids were nat utilized.

Starch not hydrolyzed. Amaral (loc.

cit.) finds hydrolysis. Lipolytic netion slight.

Aerobic.

Optimum tempemture 30°C. Maximum 35°C. Minimum 5°C.

Source: First isolated from the cassava, Manihotus utilissima in Brazil.

Habitat: Produces a wilt disease on various species of Manihotus.

Xanthomonas rubrisubalbicans (Christopher and Edgertan) comb. nor. (Phytomonas rubrisubalbicans Christopher and Edgerton, Jour. Agr. Res., 41, 1930, 266; Bacterium rubrisubalbicans Burgwitz, Phytopathogenic Bacteria, Leningrad, 1935, 105.) From L. ruber, red: subalbicans, nearly white.

Rods: Short with polar flagella. Cap-

sules. Gram-negative.

Gelatin: No liquefaction. Bacto-glucose agar colonies: Circular, glistening, viscid, milky gray to buff. Margins translucent, entire.

Broth: Turbid after 24 hours. Pellicle

and a ropy sediment.

Indole produced.

Hydrogen sulfide produced. No gas from carbohydrates.

Starch hydrolyzed.

Optimum temperature 30°C.

Optimum pH 68 to 80. Source: Isolated many times from mot-

tled stripe of sugar cane in Louisiana.

Habitat: Pathogenic on sugar cane, Johnson's grass and sorghum.

45. Xanthomonas cannee (Bryan) comb. nov. (Racterium cannae Bryan, Jour. Agr Rea., £!, 102), 152, Phylosiomas cannae Bergey et af, Manusl, 1st ed, 1923, 188; Pacudomonas coannae Stapp, ac Sorater, Hardb d. Phantenkrank, £, 5 Auft., 1928, 63) From Gr canna, a reed; M. L. Canna, agreet; nume

Rods: 0 5 to 0.7 by 10 to 20 microns Motile with 1 to 3 polar flagella Cap-

sules. Gram-negative

Celatin: Slow housfaction

Agar streaks · Filiform, white, moist, with thin margins and granular centers

Broth Turbid, heavy sediment

Milk: Alkaline and clears

Nitrates are produced from natrates

Indole not produced

Hydrogen sulfide produced
Optimum temperature 35°C Maxi
mum 40°C. Minimum 5°C

Aerobic.

Source: Isolated from thiseased canna leaves collected in Washington, D. C. and in Illinois.

Habitat: Causes discose in Canna indica.

46. Xanthomons's zingiheri (Uyeda) comb. nov. (Uyeda, Cent f Baht, IT Abti, IT, 1907, 383, Petudomonas zingiberi Uyeda, Rept. Imp Agt Exp Sta, Japan, No. 35, 1908, 114; Bacterium zingiberi Nakata, see Elliott, Man Bart Plant Path., 1890, 286, Phytomonas zingiberi Nagrou, ni Hauduroy, catal, Duet d Bact. Path., Varis, 1937, 437 ) From L zingiberis, ginger; M L Zingiber, a generic natur.

Description from Stapp, in Soraner,

Handb. d. Pflanzenkrank, 2, 5 Aufl., 1928, 65.

Rods 0 5 to 1 1 by 0 75 to 1 8 microns. Non-mottle at first, later a polar flagellum Gmm-negative.

Gelatin: Liquefaction

Agar colonies; White.

Milk: Congulation and peptonization of the casein.

Nitrates are produced from nitrates.

Indole not formed

Hydrogen sulfide is formed.

No gas from glucose

Optimum temperature 28°C, Maximum 40°C, Minimum 5°C

Source Isolated from ginger plant showing a rot at the base of the sprouts Habitat Pathogenic on ginger, Zingsber officinale.

47. Xanthomous conject (Uyeda) comb nee (Pseudomonos conject Uyeda, Bot Mag. Tokyo, 24, 1910, 182; Boterrum conjec Elholt, Man Bact. Plant Path. 1930, 121, Phylomonas conjec Magrou, in flauditroy et al., Dict. d. Bact. Path. Paris, 1937, 347.) From M. L. conjec. the specific name of the plant which this species attacks

Description from Elliott (loc cit.).
Rods 0.75 to 1.0 by 1.5 microns.
Motile with 1 to 4 polar flagella Grampositive

Gelatin colonics Circular to irregular, hight yellow

Broth Pellicle formed.

Milk Congulation Contac Littlefied

Nitrites produced from nitrates Indole produced.

Hydrogen sulfide produced

Gas from glucose

Pavorable temperature 24°C.

Habitat Pathogenic on Amorphophallus Ionjac.

Appendix I:\* The following organisms placed in the genus Pseudomonas apparently belong in Nanthomonas Some may even be plant pathogens although they were

<sup>\*</sup> Prepared by Prof Robert S. Breed, New York State Experiment Station, Geneva, New York, July, 1943.

isolated from water, soil and similar sources. Pigment is usually yellow and is not water-soluble.

Key to yellow ond other chromogenic species in genus Pseudomonas.

1. Colonics yellow.

a. Gelatin liquefied.

b. Nitrites produced from nitrates.

a Asid and are produced form of

c. Acid and gas produced from glucose.

1. Pseudomonos fermenions.

cc. Acid but no gas from glucose,

2. Pseudomonas trifolii.

3. Pseudomonos zanthe.

ccc. Action on glucose not recorded.

4. Pseudomonas caudato.

bb. Nitrites not produced from nitrates.

c. Litmus milk acid or ferment lactosc.

5. Pseudomonas perlurido.
6. Pseudomonas iridescens.

cc. Litmus milk not congulated. Yellow sediment.

7. Pseudomonos turcosa.

ccc. Litmus milk slimy, alkaline.

8. Pseudomonas ochraceo.

as. No liquefaction of gelatin.

Nitrites produced from nitrates.

c. Litmus milk, slow coagulation.

9. Pzeudomonos cerevisiae.

cc. Litmus milk, acid but no digestion.
10. Pseudomonos arguta.

ccc. No growth in litmus milk.

11. Pseudomonas subcreta.

cccc. Action on litmus milk, not recorded.

12. Pseudomonas pictorum.

bb. Nitrates not produced from nitrates.

c. Butter colored pellicle on litmus milk.

Pseudomonas lacunogenes.

cc. No surface pellicle.

 Colonies on gelatin blue center surrounded by yellow zone with peripheral green zone.

a. Gelatin liquefied.

b. Nitrites produced from nitrates.

15. Pseudomonas temonnieri.

1. Pseudomonas fermentans von Wolzogen Kuhr. (von Wolzogen Kuhr, Cent. f. Bakt., 11 Abt., 85, 1932, 228; Flaubacterium fermentans Bergey et al., Manual, 4th ed., 1934, 55) From Latin, fermento, to ferment.

Rods: 0.4 to 0.6 by 1.7 to 3.4 microns.

with rounded ends, occurring singly and in pairs. Motile, with a single or occasionally 2 or 3 polar flagella. Gramnegative.

Gelatin colonies: Circular, grayish,

with rapid liquefaction.

Gelatin stab: Liquefaction crateriform.

Agar colonies: Circular, slightly conver, opaque, gray by reflected, and light-brown by transmitted light

Agar slant: Gray, becoming yellowish Broth: Turbid with pellicle.

Litmus milk; Acid. Potato: Gray to yellowish growth

Indole is formed Nitrites produced from nitrates

Acid and visible gas from glucose, lactose and sucrose.

Acetylmethylcarbinol is formed

Ammonia is formed from peptone and asparagin.

Hydrogen aulfide is formed Starch is hydrolyzed

Lipase is formed. Catalase positive Acrobio, facultative

Optimum temperature 37°C. Distinctive character Produces gas in

lactore fermentation tubes Source. Ten cultures from the larvac

of a midgo (Chironomus plumosus) and

from filtered water. Habitat: Unknown.

2. Pseudomonas trifolil Huss. (Huss, Cent. f. Bakt., II Aht , 19, 1907, 68; Maiobacterium trifolii Bergey et al., Manual, 1sted , 1923, 111 ) From Latin, tres (tri.), three; folium, leaf, M L Trifolium, clover.

Possible synonym Bacillus annulaius Wright, (Wright, Memoirs Nat. Acad. Sci., 7, 1895, 443; Pseudomonas annulata Chester, Man. Determ. Bact , 1901, 315, Relationship to Bacillus annulatus Zimmermann uncertain. Die Bakt unserer Trink- und Nutzwässer, Chemnitz, II Reihe, 1800, 30; Flatobacterium annulatum Bergey et al . Manual, 1st ed., 1923, 310.)

According to Mack (Cent. f. Bakt., II Abt., 95, 1936, 218) the following organism is to be regarded as identical with Pseudomonas trifolii: Bacillus mesentericus aureus Winkler (Cent. f. Bakt , II Abt., 5, 1899, 577) regarded by Burri (Cent. f. Bakt., II Abt., 10, 1902, 756) and Düggeli (Cent. f. Bakt., II Abt., 12, 1901, 602)

as identical with the organism which Düggeli (loc. cit.) names Bacterium herbicola aureum. The organism studied as Bacterium herbicola by Huttig (Cent. f. Bakt., II Abt., 84, 1931, 231) is not regarded as identical with the Burri and Düggeli organism by Mack. Beijerinck (Cent. f. Bakt., II Aht., 15, 1905, 366) states that Bacillus herbicola of Burri and Düggeli is identical with his Bacillus anglomerans (Botan, Ztg., 1888, 749) If so, this binomial has priority.

Rods. 0 5 to 0 7 by 0 75 to 2 0 microns. occurring singly, in pairs and in chains, Motile, possessing a single polar flagellum. Gram-negative.

Gelatin colonies: Convex, smooth, moist, glistening, grayish-yellow. Gelatin stab. Napiform liquefaction

Agar colonies Small, circular, grayish, becoming brownish-yellow

Agar stant . Yellowish, becoming brownish-yellow streak, Iscerate margin. Broth Turbid, with grayish-yellow

pellicle and sediment. Litmus milk: Slowly coagulated; nlka-

line; with yellow ring. Potato: Thick, yellowish, flat, smooth,

glistening

Hydrogen sulfide produced Indole is formed

Acid from glucose, sucrose, xylose, arabinose, and mannitol. No acid from Inctass.

Nitrates produced from nitrates. Cultures have an agrecable odor.

Volutin formed.

Acrobic, facultative.

Optimum temperature 33° to 35°C. Source. Isolated from clover hay,

Habitat Evidently a common organism on the leaves of plants.

3. Pseudomonas ranthe Zettnow. (Zettnow, Cent. f. Bakt., I Abt., Orig., 77, 1915, 220; Flarobacterium zeltnowii Bergey et al , Manual, 1st ed., 1923, 112. Flarobacterium zanthium (nie) Bergey et al., Manual, 3rd ed., 1930, 145.) From Gr. zenthus, yellow.

Rods: 0.5 to 0.6 by 0.4 to I.4 microns. Motile, possessing a single or occasionally two or more very long (20 microns) polar flagella. Gram-negative.

Gelatin colonies: Gircular, yellow,

granular.

Gelatin stab: Pale-yellow surface growth. Brownish yellow under surface colonies. Saccate liquefaction.

Agar slant: Dark yellow, glistening, with dark yellow sediment in water of condensation. Pigment not water-solphle.

Broth : Turbid.

Litmus milk. Slightly acid. Litmus reduced.

Potato: Grayish yellow to brownish growth.

Indole formed.

Nitrites are produced from nitrates.
Acid formed in glucose.

Starch hydrolyzed.

Blood serum not liquefied.

Aerobie, facultativo Optimum temperature 30°C. Source. Air contamination.

4. Pseudomonas caudata (Wright)
Conn. (Bacillus coudatus Wright,
Memoris Nat. Acad Sci., 7, 1895, 444;
Bacterium caudatus Ghester, Annual
Rept. Del Gol. Agr Evp Sta. 9, 1897,
107, Gonn, Jour Agr Res, 10, 1919, 313;
Fluiobacterium caudatum Bergey et al,
Manual, 1st ed, 1923, 109) From
Latin, cauda, tail

Rods. Long, granular, slender, occurring singly, in pairs and in chains Appear line cocci in old cultures Motile, possessing a polar flagellum (Conn). Gramnegative.

Gelatin colonies: Yellow, translucent, smooth, undulate.

Gelatin stab: Villous growth in stab. Crateriform tiquefaction Agar slant: Yellow to orange, glisten-

ing, translucent, slightly spreading
May lose power to torm pigment.
Broth: Turbid, with yellow sediment.

Litmus milk: Unchanged.

Potato: Dark yellow, raised, rough, spreading.

Indole not formed.

Nitrites and ammonia produced from nitrates.

Ammonia produced from peptone. Starch is digested.

Aerobic, facultative. Optimum temperature 25°G.

Habitat: Water.

 Pseudomonas periurida Kellerman et al. (Kellerman, McBeth, Scales and Smith, Cent. f. Bakt., II Abt., 59, 1913, 516; also McBeth, Soil Sci., 1, 1916, 472; Cellulomonas periurida Borgey et al., Manual, 1st ed., 1923, 163.)

Rods: 0 4 by 1.0 micron. Motile with one to three polar flagella. Gramnegative.

gauve.

Gelatin stab: Liquefaction. Agar slant: Moderate, flat, faint yellow

Broth: Turbid in 5 days.

Litmus milk: Acid. Peptonization after 16 days.

Potato: Scant yellow growth with bleaching along line of growth.

Indole not formed.

Nitrites not produced from nitrates.

Ammonia is produced.

Acid from glucose, maltose, lactose, sucrose, starch, glycerol and mannitol.

Acrobic, facultative. Optimum temperature 20°C.

Source: Soil from Virginia, Louisiana and Missouri.

Habitat: Soil.

5a. Pseudomonas perlurida var. sirginiana Kellerman et al. (loc. cit.). Does not grow on potato and liquefies gelatin rapidly.

Source: Soil from Virginia.

6. Pseudomonas Irtdescens Stanier. (Jour. Bact , 45, 1911, 542.) From Latin, iridescent.

Rods: 0 2 to 0 3 by 1.5 to 7.0 microns, average length 5 0 to 6.0 microns, occurring singly. Non-motile. Gram-negative.

Sea water gelatin stab: Filiform growth. Liquefaction by some strains.

Sea water agar colonies: Concave, 2 to 3 mm in diameter, smooth, glistening, translucent, pile yellow, edge irregular. After 2 to 3 days a marked irrideseence Later colonies rough, opaque, bright yellow, sunken central portion with trans-1 colonishery.

" ---rading,

yellow, iridescent, out, ....

Sea water broth: Turbid, light yellow, granular pellicle.

Indole not formed.

Nitrites not produced from nitrates Hydrogen sulfide not produced

Catalase positive.

Urcase negative.
Acid from xyloso, glucose, galactose, factose, maltose, sucroso and cellubrose. No acid from arabnose. Starch and cellulose are attacked.

Actobic.

Optimum temperature 23°C Mintmum 5°C, Maximum 30°C.

Salt range: 0.25 to 6 0 per cent Optimum 1.0 to 4 0 per cent.

Source: Sea water

Habitat: Common along the coast of the North Pacific.

Pseudomonas turcosa (Zimmermann) Migula. (Bacillus turcosa Zimmermann, Bakl., unserer Trink. und Natradeser, Chemnitz, f. 1891, 32, Migula, Spet d. Ilakt. f. 1900, 337, Hara-bacterium turcosum Biergey et al., Man ud., Ist. ed., 1923, 111) From M. L. (urens, tumpulose

Rods: 0.5 by 1.05 to 1.52 microns, or curring singly. A short polar flagellum (Nigula). Gram-negative

Gelatin colonies · Small, translucent, yellow,

Gelatin stati Small, yellow, enaver surface growth, with slight brownish that. Liquefaction, with grayish to greenish color in figurated perturn

Ager slant. Abundant, glostering, greenish to sulfur yellow street.

Broth: Slightly turbid with yellow sediment.

Sediment.
Litmus milk: No coagulation. Yellow sediment.

Potato: Clear chromium yellow growth over entire surface.

Indole is not formed.

Natures not produced from nitrates.

Acid from glucese. Slight action on sucrose

Aerobie, facultative.

Optimum temperature 80°C.

Source Isolated by Tataroff from a well in Dorpat (Die Dorpaten Wasserbakterien, Inaug. Diss., 1891, 52, No. 21).

Habitat Water, sea water.

8 Pseudomonas ochracea (Zimmermann) Chester, (Bacillus ochraceus Zimmermann, Itakt. unserer Trinks und Nuttuässer, Chemnitz, 1, 1850, 60; Chester, Determantur Bacteriology, 1901, 316; Flarobacterium ochraceum Bergey et al. Manual, 1st ed., 1923, 110; Chromobacterium ochraceum Topley and Wison, Prine Bet and Immun, 1, 1931, 405.) Fram Greek, ochras, pale yellow.

Rods 07 to 08 by 12 to 45 microns, occurring in pairs and longer chains. Slow undulatory motion (Zimmermann). Polar flagella (Lehmann and Neumann, Bakt Dang, 1 Aufl., p. 1896, 255). Grammerstein.

Bakt Ding , I Auli , 2, 1896, 200) Gramnegative Gelatin colonies Pale yellon to golden, orders ellon, eightly rased, with slightly

fringed margin, granular
Gelaim with Vellowish to yellow-gray
surface growth. Infundibuliform liquefaction. Pale yellow to other yellow
sechment.

Arts estimics. Thun, flat, pellowish, smooth

Agar slant: Thin, yellowish gray to orbinecous growth

Brach Sixtly turbed, with pare yel-

Latrica milk. Medium becomes slimy; alkaline.

Porato Ochre pellor stresh Indde is formed, Nitrites not produced from nitrates. Hydrogen sulfide is formed. Aerobic, facultative. Optimum temperoture 35°C. Source: Chemnitz tap water. Habitat: Water.

9. Pseudomonss cerevisise Fuhrmann. (Fubrmann, Cent. f. Bakt., II Abt., 16, 1906, 309; Flatobacterium cerevisioe Bergey et al., Manual, 1st ed., 1923, 111.) From Latin, cereusia, beer.

Rods: Straight and slightly curved, 0.6 hy 1.5 to 2.0 roierons, occurring singly and in chains. Mottle, possessing tuft, four to six polar flagella. Gram-negative.

four to six polar liagella. Gram-negative.
Gelatin colonies: Circular, white,
slightly contoured, hecoming brownishvellow.

Gelatin stab: Slight yellowish growth in stab. No liquefaction.

Agar colonies: Thin, spreading, contoured.

Agar slant: Moist, glistening, thin, pale yellow, spreading, contoured.

Litmus milk · Slow coagulation.

Potato: Yellowisb brown, spreading growth.

Indolo not formed. Nitrites produced from nitrotes. No gas from glucose.

Aerobic, facultative.
Optimum temperature 30°C
Source: Isolated from beer.
Habitat: Unknown.

10. Pseudomonas arguta McBeth. (McBeth, Soil Science, 1, 1916, 465; Cellulomonas arguata (sic) Bergey et al., Manual, 1st ed., 1923, 164.) From Latin, orguo, to show.

Rods: 0.3 by 0 8 mieron. Motile with one or two polar flagells. Gram-negative. Gelatin stah: Moderote, yellowish

growth. No liquefaction in 30 days.
Agar colonies: Circular, slightly con-

vex, soft, grayish-white, granular, entire.

Agar slant: Scant, grayish-white
growth.

Potato agar slant: Moderate, yellowish, glistening. Broth: Turbid.

Ammonia cellulose agar: Enzymatic zone 2 to 3 mm in 30 days.

Filter paper broth: Paper is reduced to loose flocculent mass which disintegrates very readily on slight agitation. More rapid decomposition when the hroth contains ammonium sulfate, potassium nitrate, peptone or casein as sources of nitrogen.

Litmus milk: Acid, not digested.

Potato: No growth.

Indole not formed.

Nitrites produced from nitrates.

Ammonia not produced,

Acid from glucose, maltose, lactose, stareb. No acid from glycerol, mannitol or sucrose.

Aerobic, facultative.

Optiroum temperature 20°C.

Source: Isolated twice from California
soils.

Habitat : Soil.

11. Pseudomonas subcreta McBeth and Scales. (McBeth and Scales, Bur. Plant Industry, U. S. Dept. Agr., Bul. 266, 1913, 37; Cellulomonas subcreta Bergey et al, Manual, 1st ed., 1923, 164.) From Latin, sub, under, imperfect; creta chalk.

Rods: 0 3 hy 1.4 microns. Motile with one to five polar flagella. Gram negative-Gelatin stab: Filiforro growth, no lique-

faction.
Cellulose agar: No surface growth.
Moderate, generally faint yellow growth

in roedium, area of growth sunken.

Agar slant: Glistening, smooth, moist,

vitreous to faint yellow.
Starch agar: Enzymatic zone 2 to 4 mm.
Broth: No growth.

Litmus milk: No growth.

Potato: Growth scanty, concave due to slight liquefaction, white to faint yellow.

Bleached around growth. Indole not formed.

Troce of nitrites produced from nitrates.

Ammonia not produced.

Acid from glucose, lactose, maltose,

sucrose and starch. No acid from glycerol or mannitol

Aerobic, facultative

Optimum temperature 20°C Habitat : Soil.

Pseudomonas pictorum Gray and Thornton. (Gray and Thornton, Cent. f. Bakt, II Abt, 75, 1928, 89, Achromobacter pictorum Bergey et al . Manual, 3rd ed., 1930, 217) From Latin, picts, the Picts of Eastern Scotland.

Rods: 0.5 to 0.8 by 1 5 to 50 microns Motile usually with a single polar flagellum. Gram-negative

Gelatin colonies Circular, greenishyellow, convex, smooth, glistening, entire.

Gelatin stab: No liquefaction

Agar colonies: Circular, yellow, convey,

smooth, glistening, entire Agar slant Filiform, yellow, convey,

smooth, glistening, entire Broth : Turbid.

Nitrites produced from nitmies Starch not hydrolyzed

Acid from glucose and maltose

Attacks phonol.

Aerobic, facultative. Optimum temperature 25°C

Source: One culture from soil Habitat : Soil

13. Pseudomonas lacunogenes Goresline. (Jour Bact, 26, 1933, 447) From Latin lacuno, dimple and genero, to produce.

Short rods. 0.2 to 03 by 10 to 12 microns, with pointed ends, occurring singly or in pairs Mottle with a single polar flagellum from 2 to 15 microns in length Gram-negative

Plain gelatin stab No growth

Nutrient gelatin stab Growth brownish-yellow, half-way down stab, heavier at surface. No hquefaction Nutrient agar colonies Small, yellow,

surface of the agar pitted or dimpled After 5 days colonies 5 to 7 mm in diameter, orange-yellow, slightly raised, surrounded by a depression.

Nutrient agar slant: Growth heavy, light orange-yellow, consistency of warm butter, edge entire, slightly raised Shallow depression formed on each side of streak. Agar softened beneath growth.

Nutrient broth . Turbid in 48 hours. Light orange-yellow pellicle; considerable viscous sediment.

Litmus milk. Alkaline; butter-colored pellicle. Reduction in bottom of tube after 10 days. No curd. No digestion

Potato Growth moderate, orange-yellow, smooth No darkening

Indole not formed.

Natrites not produced from pitrates. Starch agar plates not hydrolyzed.

Utilizes ambinose, galactose, lactose, fructose, maltose, melezitose, raffinose, starch, vylose, glucose, mannose, sucrose, pectin, rhamnose, saliein and dextrin No growth in dulcitol, erythritol, glycesol, sorbitol, mannitol or inulin.

Limits of pll: 54 to 100

Temperature relations Optimum 28°C. Good growth at 25°C. Moderate growth at 20° and at 37°C No growth at 10° and at 42°C

Facultative apperobe.

Distinctive characters. Softens amer: considerable change in viscosity of agar due to this digestion; utilization of ammonium sulfate as nitrogen source

Source. Three cultures isolated from an experimental trickling filter receiving creamery wastes.

Habitat Probably widely distributed in sisture.

14 Pseudomonas segnis Gorceline (Jour Bact , 26, 1933, 452 ) From Latin seque, non-energetic

Short rods 92 to 03 by 19 to 12 mierons, with pointed ends, occurring singly or in pairs. Mottle with a single polar fingellum Gram-negative

Phin gelatin stab; No growth,

Nutrient gelatin stab: Growth sellow, half-way cloud stab, best at surface No haucfaction.

Nutrient agar colonies: Very small, light yellow; surface pitted. After 5 days colonies 5 mm in diameter.

Nutrient agar slant: Growth heavy, orange-yellow, consistency of warm butter; edge entire, slightly raised; slight depression formed on each side of growth. Agar softened beneath growth.

Nutrient broth: Turbid in 48 hours. No pelliele or surface growth. Moderato amount of sediment. Old cultures with a yellow ring at surface and occasionally n loose membrane.

Litmus milk: Slightly alkaline after 10 days. No reduction. No surface growth. Potato · Scant yellow-orange growth.

No darkening.

Indolo not formed.

Nitrites not produced from nitrates. No II<sub>2</sub>S produced.

Starch not hydrolyzed.

Utilizes ambinose, glucose, galactose, lactose, fructose, maltose, mannose, vylose, sucrose, melezitose and raffinose. Limits of pH: 58 to 9.0.

Temperature relations: Optiraum 28°C. Good growth at 25°C. Moderate growth at 20° and at 37°C. No grawth at 10° and at 42°C

Facultative anaerobe.

Distinctive characters: Softens agar; considerable change in viscosity of agar due to this direction.

Source Isolated from an experimental trickling filter receiving creamery wastes. Habitat: Probably midely distributed in nature.

15. Pseudomonas lemonnieri (Lasseur)
comb nov (Bactilus lemonnieri Lasseur)
Compt. rend Soe Biol. Paris, 74, 1913,
47; Bul. de la Soe. des Sci. de Nancy,
1924; Flavobacterium lasseuri Bergey et
19. Manual, 3rd ed., 1930, 144.) Named
for Prof. G. le Monnier, s French
scientist.

Rods 05 to 07 by 10 to 2.0 microns, occurring singly and in pairs. Motile

with a single polar flagellum. Gramnegative.

Gelatin colonies (glucose): Circular with blue center, a granular, yellow zone and a peripheral blue zone. Rapid liquefaction with blue crystals.

Gelatin stab : Liquefied.

Agar colonies: Circular, yellowish, lobate margin.

Agar slant: Yellowish streak, smooth,

glistening.
Broth: Turbid with thin pellicle.

Litmus milk: After 48 hours the surface of the milk becomes yellow to cream color turning blue. A soft coagulum is formed.

Potato: Raised growth, Prussian blue in color, with variations.

Indolo is not formed

Nitrites produced from nitrates. Aembic, facultative.

Optimum temperature 22° to 25°C. Habitat: Water.

Appendix II:\* The following inadequately described species may belong to the genus Xanthomonas.

Bacterium eitri deliciosae Passalsequa. (Rev. Pat. Veg., 24, 1934, 27.) Isolated from Citrus sp.

Bacterium malvacearum var. barbadense Evelyn. (Ann. Rept. Agric. Barbades for 1926-27, 1928, 15.) Isolated from cutton.

Pscudomonas amaranti (sic) Smith. (U. S. Dept. Agr., Div. Veg. Phys. and Path. Bull., 23, 1901, 153; Bacterium amarantii Smith, Bact. in Relation to Plant Dis. 5. 1914, 148; Phytomonas amarantii Bergey et al., Manual, 1st ed., 1923, 183) Isolated from diseased amarantus. Growth in culture similar to Xanihomonas campestris and Xanthomonas hyacinthi.

Pseudomonas alutacea Migula. (Ledergelber Bacillus, Tataroff, Die Dorpater Wasserbakterien, Inaug. Diss., Dorpat,

<sup>\*</sup> Prepared by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, July, 1943.

1891, 61; Migula, Syst. d. Bakt., 2, 1900, 936) Isolated from water.

Pseudomonas graveolans Migula (Bacillus aqualilis graveolens Tataroff, Die Dorpater Wasserbakterien, Inaug Diss, Dorpat, 1801, 48; Migula, Syst. d. Bakt., 2, 1900, 931.) Isolated from water Not Pseudomonas graveolens Levine and Anderson (Jour. Bact., 23, 1932, 313) isolated from musty eggs, and by Olsen and Hammer (Iowa State Coll. Jour. Sci., 9, 1931, 125) from milk.

Pseudomonas resinacea Migula. (Harrfarbener Bacellus, Tataroff, Die Dotpater Wasserbakterien, Inaug. Diss., Dorpat, 1891, 64; Migula, Syst. d. Bakt., £, 1900, 935 ) Isolated from water.

Xanthomonas tarazac: Niederhauser (Phytopath., 53, 1943, 961.) Pathogenie on Russian dandelion (Tarazacum kol-saghz)

# Genus III. Methanomonas Orla-Jensen \* (Cent I. Bakt., II Abt., 25, 1909, 311.)

Cells monotrichous, capable of obtaining energy from oxidation of methane to CO, and water.

The type species is Methanomonas methanica (Söhngen) Orla-Jensen,

Methanomonas methanica (Sobngen) Orla-Jensen. (Bacillus methanicus Schngen, Cent. f. Bakt, II Abt. 16, 1906, 513; Orla-Jensen, Cent. f. Bakt, II Abt., 22, 1909, 311) From methane

Bhort rods, 05 to 05 by 20 to 30 miletons, motile in young cultures by means of a single flagellum. In older cultures nearly spherical, Can be culturated us an atmosphere composed of one part CII, and two parts air on washed agar containing the acceptary inorpanic saits. The growth is mighbranous.

Genus IV Aceto.

At the end of two weeks, the organisms changed an atmosphere containing 225 ml. CHz and 321 ml. Oz to the following

In addition, 21 ml. CO, was dissolved in the liquid.

Habitat · Presumably widely distrib-

Genus IV Acetobacter Beigerinek †

(Proc Kon Akad v. Wetenschapp , Amsterdam, 2, 1900, 495.)

Actibucter acets first appeared (Kral's Sammlung v. Mikroorg., Prague, 1898, 4) as ayingym of Bacterum acets Hansen. Beijennek (foe. cet) mentions Acetobacter acets in Lafontote of a later paper. The genus name declobacter was accepted by Fuhrmann Greinfelt Bot Centralibl., Orig. 19, 1905, 8) and others. From Latin, acetum, vincigar, bacterum, rod

Synonymy Mind Kütring, Algae aquav dulcis, etc., 11th decade, 1837; Myco-derna Thompson, Ann d'Chem u Pharmacie, 33, 1822, 89; TUmbina Nargell, Bericht Ober die Verlanddingen der bot Section der 33 Versammlung deutscher Natur-dorscher, und Arater Bot Zig, 1857, 700, Bacterum Lansi, N. Giorn, bot, ital., 1876, 231; Torula Sacradio, Atto See Ven Trent, 5, 1858, 315; Bacteropris (io part) Trevisum, Atti Accad Fitto-Modro-Statistica Milano, Ser 4, 3, 1853, 107; Microaccus Maggi, Jour, Microg., 10, 1856, Bactluw Schroeter, Kryptogamen Flora von Schrösen, 5, 1, 1859, 151; Termobacterum Zeidler, Cent I Batt, 1, 1 Abt., 2, 1890, 733, Accidost.

Prepared by Prof D II Bergey, Philadelphia, Pennsylvania, December, 1922.
furleysed by Dr. C D Kelly, McGill Umv., Montreil, P. Q., Canada, July, 1938;
furley revision by Dr. Reese H. Vaughn, Univ. of California, Berkeley, California
June, 1913.

terium Ludwig, in abstract of Hoyer's Inaug. Diss., Cent. f. Bakt., II Abt., 4, 1898, 867; Acetimonas Orla-Jensen, Cent. f. Bakt., II Abt., 22, 1909, 312.

In addition, the sub-generic names Euacetobacter and Acetogluconobacter have been proposed by Asai, Jour Agr. Soc. Japan, 11, 1935, 502. The genus Gluconobacter and the sub-genera Eugluconobacter and Gluconoacetobacter Asai (loc. eit.) may be

synonyms in whole or in part.

Individual cells ellipsoidal to long and rod-shaped, occurring singly, in pairs, or in short or long chains. Motile with polar flagella, or non-motile. Involution forms may be spherical, clongated, filamentous, club-shaped, swollen, curved or even branched. Young cells Gram-negative; old cells often Gram-variable. Obligate acrobes; as a rule strongly catalase positive, sometimes weakly so. Oxidize various organic compounds to organic acids and other oxidation products which may undergo further oxidation. Common oxidation products include acctic acid from ethylalcohol, gluconic and sometimes ketogluconic neid from glucose, dihydroxyacoton from glycerol, sorbose from sorbitol, etc. Nutritional requirements vary from simple to complex. Development generally best in yeast infusion or yeast autolysate media tilt added ethyl alcohol or other oxidizable substrate. Optimum temperature variable with the species. Widely distributed in nature where they are particularly abundant in plant materials undergoing alcoholic fermentation; of importance to man for their role in the completion of the carbon cycle and for the production of vinegar.

The type species is Acctobacter aceti (Kutzing) Beijerinek.

## Key to species of genus Acetobacter.

- I. Oxidize acetic acid to carbon dioxide and water.
  - A. Capable of utilizing ammonium salts as a sole source of nitrogen (Hoyer's solution) \*
    - 1. Acetobaeter aceti.
  - B Do not utilize ammonium salts as a sole source of nitrogen.\*
    - Forms a thick, zooglocal, collulose membrane on the surface of liquid media
      - 2. Acetobacter zylinum.
    - Do not form a thick, zooglocal membrane on the surface of liquid media.
      - 3. Acetobacter rancens.
      - 3a. Acetobaeter pasteurianum.
      - 3b. Acetobacter kuelzingianum.
- II. Do not oxidize acetic acid.
  - A. Form pigments in glucose media.
    - 1. Dark brown to blackish mement.
      - 4. Acetobacter melanogenum.
    - Pink to rose pigment.
- 5. Acetobacter roseum.
- B. Do not form pigments.
  - Optimum temperature 30° to 35°C.
  - 6. Acetobacter suboxydans.
  - 2. Optimum temperature 20° to 25°C,
    - 7. Acetobacter oxydans.

<sup>\*</sup> It is not known with certainty whether Acetobacter pasteurianum and Acetobacter kuetzingianum are capable of using inorganic nitrogen as a sole source of nitrogen for growth. However, since these two species are among those first described it is advisable to retain them for the present. See Acetobacter rancens Beijerinck.

1. Acetobacter acett (Kützing) Beijerinck. (Ulrina aceti Kützing, Algae aquae dulcis etc. 11th derade, 1837. Mycoderma acets Thompson, Ann d Chem. u. Pharmacie, 83, 1852, 89. Umbina accti Naegeli, Benefit über die Verhandlingen der bot. Section der 33 Versammlung deutscher Naturforscher und Arster, Bot. Zig , 1857, 760, Bacterium aceti Lanzi. N. Giorn, bot stal-1876, 237; Torula aceti Sacrardo, Atti See Ven. Trent., S. 1878, 315, Bacteriopsis aceti Trevisan, Atti della Accademia Lisio-Medico-Statistica in Milano, ber 1, 5, 1885, 103; Micrococcus aceli Mazzi. Jour. Microg., 10, 1886, Racillus acets Schmeter, Kryptogamen Plom von Schlesien, 5, 1, 1886, 161, Bacillius acctions Plage, Die Mikmorganismen, 186, 311, Heljeriack, Rent's Sammlung v. Mikroorg , Prague, 1898, 7, Benjemark, Proc Kon, Akad, v. Wetensch , Amsterdam 2. 1900, 495; Bacterium hansenianum Cheyler, Man, Determ Bact , 1901, 126 . From Latin neeture, vincent

Rode: 0.4 to 0.8 by 1.0 to 2.0 merous, occurring singly and in long chains, frequently shaving large claim birged forms. Strin yellow with beliene relation. Matthly variable. Mottle cells powers a single jeder fixedium (Vangha, John Phet, 12, 1911, 202). Perms large, share relations on lever g-latin containing. If per cent settings.

forms slimy pellicle on fluctured a or ting or turbulity without pellicle

Arid from glusse, ethal alvid propilated anti-pla propilated anti-pla Novarilities after element plates after element, rather, land, and alvid element in the element plates and alvid element plates and alvid element plates and alvid element eleme

Distriction of smarters. Marked in the language of the first and ample to the language of the marked of which and admirate on a first and a marked of shared on the first of the language of t

gen salts as a sole source of nitrogen (Hoyer, Inaug. Dies, Leiden, 1898, 43; Beigeinek, Cent & Bakt. H. Aht., 4, 1898, 215); growth and oxulative activity in association with fermenting years (Yaughn, Jour. Bact., 53, 1998, 200)

Optimum temperature 3/1°C Growth occurs between 10° and 42°C

Habitat: Vinegar; souring fruits, vegetables and beverages.

2 Acetobacter sylfiam (Brown) Holhad (Bacterium zilnum Brown, John Chem Soe, London, 42, 1885, 439; Hulland, John Bret, 5, 1920, 216; Bacillus zilnum Holland, Johd, 22) From Gr. zilnum, wesden (in reference to the cellules ein the membrine)

Rods, about 2 microns long, occurring singly and in claims. The cells have a claim envelope which gives the cellulose treation.

A film forms on the surface of liquids. This film becomes cartilaterious and falls to the bettom. This suspiced film forms on all liquid medis in which growth occurs, the nature of the firefulni influence site thickness of the film which may see from 1 to 250 millimeters.

X ray pattern anoles made by Khousine, Clampeter and Satra (Compt rent Aral Ser Patis, 191, 1912, 193), and by Bertal and Hildert (Can Jour Reservel, 1919). Two layers along that the cellulate contacted in the rent rates free of by Arat Satte rajle, man there at any next settlets.

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about the second or got

Habitat: Vinegar; souring fruits, vegetables and beverages.

3. Acetobacter rancens Beijerinck. (Bacterium rancens Beijerinck, Cent. f. Bakt., II Abt., 4, 1803, 211; Beijerinck, Kral's Sammlung v. Microorg., Prague, 1898, 4.) From L. rancens, being rancid

Beijerinck (loc. cit.) in a footnote stated that "two of the many varieties of B. rancens have been described by Henneberg under the names of B. oxydans and B. acctosum. Hansen erroneously called this species B acctif as did Brown. Neither Hansen nor Brown knew B. acctif Pasteur." No further morphological description is given.

The following description is taken in part from a study of a culture of Aceto-bacter rancens received from Kluyver (Yaughn).

Rods with the usual morphological appearance of cultures of acetic acid bactoria Gram negative Motility variable, Motile cells possess a single polar flagellum (Vaughin, Jour Back, 48, 1943, 394). Involution forms commonly appear as filaments and enlarged cells.

Wort agar slant: Growth abundant, butvrous, pale-buff in color in one week.

Yeast infusion, glucose, calcium carbonate slant: Growth abundant, buttrous and cream-colored in one week.

With petri dish cultures well isolated colonies are large, smooth and butyrous on either medium.

Broth cultures containing peptono or yeast infusion form a muclaginous, slimy pellicle. Beijerinek (toc. cit.) called this polysaceharide pellicle, cellulose-like and intimated that the muclaginous material in the pellicle was somewhat different from that produced by Acctobacter xylinum. The pellicle material stained blue when treated with iodine and hydroiodic acid.

Acid from glucose, ethyl alcobol, propyl alcohol, butyl alcohol, glycol, adonitol, mannitol and sorbitol. No acid from numerous other compounds tested. Distinctive character: Production of a thin, mucilaginous, slimy, polysaccharide membrane on the surface of liquids as compared with the thick, true cellulose membrane of Acciobacter zylinum grown under the same conditions. Beijerinek (loc. cit.) reported the production of a cellulose-like membrane with some cultures of Acciobacter rancens.

Source: Isolated from shavings in the quick vinegar process.

Habitat: Found in fermented grain mash, malt beverages, mother of vinegat, Beijerinck (Cent. f. Bakt., II Abt., 4, 1803, 211) thought that the next two shocies were hardly more than varieties

of Acctobacter rancens.

3a. Acetobacter pasteurianum (Hansen) Beijerinek. (Mycoderma pasteurianum Hansen, Compt. rend. d. Trav. d. Lab. d. Carlsberg, J. 1879, 96; Bacterium pasteurianum Zopf, Die Spaltplite, 2 Aufl., 1881, 49; Beijerinek, Kml's Sammlung v. Mieroörg., Prague, 1898, 7.) Named for Pasteur, the French chemist and bacteriologist.

Rods: 0.4 to 0.8 by 1.0 micron, occurring singly and in chains, at times showing thick, club-shaped forms. Motility variable. Motile cells possess a single polar flagellum (Vaughn, Journact, 46, 1913, 391). Stains blue with iodine.

Wort gelatin colonies: Small, circular, entire, gray, slimy.

Forms a dry, wrinkled folded pellicle on double beer with one per cent alcohol. Meat infusion gelatin: Widespread,

Meat infusion gelatin: Wides later resette form, toothed.

Acid from glucose, ethyl alcohol, propyl alcohol and glycol. No acid Irom arabinose, fructose, galactose, sorbose, sucrose, maltose, lactose, raffinose, detrim, starch, glycogen, inulin, methyl alcohol, isopropyl alcohol, butyl alcohol, isopropyl alcohol, butyl alcohol, erythritol, mannitol, dulcitol and actal-dehyde (Henneberg, Die deutsch. Essignat. g. 1898, 147).

Aerobic.

Optimum temperature 30°C. Growth occurs between 5° and 42°C.

Habitat: Vinegar: beer and beer wort

3b. Acciobacter kuetzingianum (Hansen) Bergey et al (Bacterium kuetzingianum Hansen, Compt. rend. d. Trav d. Lab. d. Carlsberg, 3, 1894, 191; Bergey et al., Manual, 1st ed., 1923, 35) Named for Kuetzing, the German botanist

Short, thick rods, occurring singly Rarely forming chains of notable length Capsule stained blue with rodine and with potassium iodide. Non-motile

Double beer gelatin colonies Small, entire, with vermiform surface

Wort gelatin colonies: Small, entire, with surface free of wrinkles

Double beer: Forms a rather thick, folded pellicle. Distinguished from Acc-tobacter acets in showing heavier growth above the surface of the media

Acid from glucoso, ethyl alcohol, propyl alcohol and glycol. No acid from arabinoso, fructose, galactose, sorbose, sucrose, maltose, lactose, raffinoso, devitin, starch, glycogen, inulin, nocthyl alcohol, isopropyl alcohol, butyl alcohol, isopropyl alcohol, butyl alcohol, glycerol, orythritol, mannitol, dulettol and actal-delyde (Ilenneberg, De deutsch Essiguad, \$1803, 147).

Aerobie.

Optimum temperature 31°C, maximum 42°C, minimum 6 to 7°C

Habitat: Beer. Found in double beer

4. Acetobacter roelanogenum Berjerinek. (Cent. f Bakt., II Abt., 29, 1911, 175) From Greek melas (melan), black; genes, producing.

Rods. Non-motile or motile. Motile cells possess a single polar flagellum (Vaughn, Jour. Bact. 46, 1943, 394)

Gelatin: Apparent Inquefaction probbly caused by acid, not an enzyme When held on artificial media for some time, the power of Inquefying gelatin is lost, probably due to a slower production of acid. Deep brown pigment produced; gelatin becomes insoluble in boiling water and in trypsin solution.

Beer- or wort-gelatin plates: Characteristic dark brown, wide-spreading, diffuse areas.

Tap water-agar-glucose-peptone-potassium phosphate-iron citrate-chalk medium: In 24 hours at 30°C, black, spreading, diffuse areas.

Utilizes peptone as a source of nitrogen Produces the pigment from peptone only if maltose or glucose is present as a source of carbon. When grown in glucose-peptone broth with CaCO, at 25° to 30°C, black pigment is produced after several weeks, and the carbonate is changed to raleium gluconate.

Pigment: The pigment causing the brown coloration is an aromatic substance which is blackened by iron calts. Reduces alkaline solutions of silver and mercury, blackening them

Oxidizes mannitol and sorbitol to fructose and sorbose. Does not attack sucrose and fructose Much gluconic acid produced Acid from glucose and maltose Acetic acid produced from alcohol

Distinctive character: The formation of dark brown to black pigment in media containing a suitable substrate; particularly glucose.

Source Isolated from beer.

Habitat: Causes light-colored heer to become darker brown. It is a very strong beer-vinegar bacterium. Also found in souring fruits

Acetobacter roseum Vaughn. (Bacterium hoshiçak) var. rosea Takabasha and Asai, Cent f Bakt, II Abt., 62, 1930, 230; Acetobacter hoshigati Bergey et al., Manual, 4th ed., 1931, 39, Vaughn, Wallerstein Lah. Communications, 6, No. 11, 1912, 20) From Latin, rosa, rove.

Rods: 07 to 09 by 1.5 to 1.8 microns, generally occurring singly, at most in pairs, often in chains. Non-motile. Pellicle on fluid media yields no starch or cellulose traction. Koji (a mixture of rice and mold spores used to start fermentation of Japanese bread and saké) extract agar colonies: Small, granular, circular, glistening, umbonate, becoming brownish.

Wort agar colonies: Circular, milkywhite, becoming brownish in center and

yellowish at periphery.

Glucose saké agar: Circular, milkywhite, granular, umbonate, entire.

Hoshigaki (dried persimmons) extract agar: Circular, milky-white, granular, becoming yellowish-brown in the center and grayish-white at the periphery.

Koji extract agar streak: Grayishwhite, glistening with ciliate margin, becoming purple brown to brown.

Koji extract: Turbid with thin film, ascending on wall of tube.

Bouillon: Turbid with ring formation.
Yeast infusion glucose agar: Colonics
similar to those on wort agar.

Yeast infusion glucose broth: Turbid

with thin, ascending film.

Red color produced on saké wort agar and all media containing calcium carbonate

Acid from glucose, fructose, galactose, arabinose, glycerol, mannitol, ethyl nnd propyl alcohol. No acid from maltose, sucrose, lactose, raffinose, devirin, stareli, inulin, sorbitol, glycogen, isodulcitol and methyl alcohol

Forms gluconic acid from glucose.

Acrobic.

Optimum temperatures 30° to 35°C; maximum 40° to 41°C, minimum 10° to 15°C.

Thermal death point 50°C for 5 minutes

Distinctive character: The formation of a rose to red pigment in suitable media; particularly those containing glucose and calcium carbonate.

Source Isolated from fermenting mash of dried persimmons (hoshigakı), and souring figs and dates.

Note: Vaughn, Wallerstein Lab Communications, 5, No. 14, 1912, 20, has proposed the name Acetobacter roscum to replace the name Acetobacter hoshigali As originally described, this organism was given the name Bacterium hoshigaki var. rosca by Takahashi and Asai (loc. cit.) without the authors having first named and described the species Bacterium hoshigaki. The Japanese word 'hoshigaki' has been uved in a confusing manner vir. Takahashi and Asai, loc. cit. (Bacterium industrium var. hoshigaki) and Takahashi and Asai, Jour. Agr. Chem. See, Japan, 9, 1933, 331 Jour. Agr. Chem. See, Japan, 9, 1933, 333 (Bacterium hoshigaki var. glucuronium I, Il and III). None of these Japanese names are in the form of true binomials.

6. Acetobacter suboxydans Kluyver and de Leeuw. (Paper read at the convention of the Dutch Society of Microbiology, Utrecht, December, 1923, see Tijdschrift v. Vergelijkende Geneeskunde, 10, A3. 2-3, 1921.) From L. sub, under, less; Gr. ozys, sharp, acid; dans, giving, i.e. less neid giving; less oxidizing. Short rods: Occurring singly or in

chains Non-motile. Morphologically like Acetobacter rancens.

Forms your thin hardly visible policies

Forms very thin, hardly visible pellicle on fluid media.

Wort agar colonies: Very small, circular, slightly yellow.

Acid from ethyl alcohol, propyl alcohol, glycol, glucose, glycerol and sorbitol.

Optimum temperature 30°C.

Distinctive character: Partial oxidation of substrates as indicated by the formation of calcium 5-keto gluconate crystals on the surface of agar slants containing glucose and calcium carbonate.

Source: Isolated from spoiled beer.

Habitat: Beer.

Acetobacter oxydans (Henneberg)
 Bergey et al. (Bacterium oxydans Henneberg, Cent. f. Bakt. 11 Abt. 5, 1807,
 Bacullus oxydans Migula, Syst. d. Bakt., 2, 1900, 800; Bergey et al., Manual,
 Ist ed., 1923, 36.) From Gr. oxys, sharp,
 acid, dans, giving.

Rods 08 to 12 by 24 to 2.7 microns, occurring singly and in chains. Motile

cells possess a single polar flagellum (Vaughn, Jour. Bact., 46, 1943, 394) The chains show bud-like swellings

Gelatin colonies: Circular, becoming irregular in shape with peculiar ramifications.

Acid from arabinose, fructose, glucose, galactose, sucrose, maltose, raffinose, dextrin, ethyl alcohol, propyl alcohol, erythritol, mannitol, glycol and glycerol No acid Irom sorbose, lactose, starch, glycogen, inulin, methyl alcohol, isoptopyl alcohol, butyl alcohol, isoptuyl alcohol, myl alcohol, dulertol and acetal-dehyde (Henneberg, Die deutsch Essignal, g. 1893, 147).

Aerobic

Optimum temperature 18° to 21°C Distinctive characters Low optimum

temperature for growth and evulation of substrates; and the ability to evulate a large number of substrates

Habitat : Beer.

Appendix: The following species have been described, but until more comparative studies have been made, no cliange in nomenclature is recommended or advisable

1. Aeetobacter zeidleri Beijerinck (Termobacterium aceit Zeutler, Cent I Bakt, 11 Alt, 2, 1896, 739, Bacterium zeidleri Beijerinck, Aeetobacter zeidleri Beijerinck, Kral's Sammlung v. Mikroofg, Prague, 1899, 7, Bacillus zeidleri Migula, Syst d. Bakt, 2, 1000, 801, Aeetobacter Indaeri Bergey et al., Manual, 1st ed., 1923, 36) Named for A. Zeidler, who first isolated this specres

Rods, occurring singly and in chains, showing large sausage-shaped involution forms. Mottle with a single polar flagellum (Zeidler, Cent I Bakt, II Abt., 4, 1809, 669).

Wort gelatin Small, circular, slightly granular, yellowish-brown, entire colonies. No liquefaction

Dirty, yellowish-brown pellicle on liquid media.

Wort gelatin slant : Strongly glatening,

transparent, whitish in center, smooth, very weakly liquefied

Potato: Very scant growth

Actd from glucose, ethyl alcohol, propyl alcohol and glycol No acid from arabinose, fructose, galactose, mallose, lactose, roffinose, devtriu, glycogen methyl alcohol, isopropyl alcohol, isoproyl alcohol, isofutyl alrohol, amyl alcohol, glycorol, mannitol and acetaldehyde (Henneberg, Die deutsch Essigind, £, 1898, 147).

Aerobic, facultative. Optimum temperature 25°C.

Optimum temperature 25°C Habitat: Beer wort.

2 Acetobacter acetosum (Henneberg) Bergey et al. (Bacternum acctosum Henneberg, Cent I Bakt, II Abt, S, 1807, 223, Bergey et al., Manual, 1st ed., 1923, 36) From Latin, acetum, vinegar.

Rods .0 4 to 0 8 by 1 0 micron, occurring singly and in chains Non-motile. Stains yellow with iodino.

On beer, yeast water and glucose solutions a firm, coherent, uniform, smooth, white film that becomes folded (Henneberg, Garungsbakt., £, 1926, 201).

Acid from glucose, galactose, chlyl alcobol, and propyl alrohol. No acid fromaralmose, fructose, sorbose, sucrose, maltose, lactose, raffinose, dettrin, starch, glycegen, inulun, methyl alcohol, isopropyl alcohol, butyl alcohol, isobutyl alrohol, amyl alrohol, glycerol, erythritol, mannitol, dulcitol and acctaldehydo (Henneberg, Die deutsch Essigmd, 2, 1933, 147).

Optimum temperature 28°C, maximum 36°C, minimum 8°C (Henneberg, Cent. f. Bakt., II Abt., 4, 1898, 14).

Habitat : Beer.

3 Acetobater ascendens (Henneberg) Bergey et al. (Hacterium ascendens Henneberg, Zeitschr. 1. deutsche Essignd., Berlin, No 19 to 23, 1898, 145, 480 eec Cent. f. Bakt., II Abt. 4, 1998, 933, Bergey et al., Manual, 1st ed., 1923, 37.) From Latin, ascendo, pp. ascendens. ascendos.

Rods, occurring singly, rarely in chains.

Non-motile. Do not give the cellulose reaction with iodine solution.

Glucose gelatin colonics: Dry, white, with white area surrounding the colony. Fluid cultures have a tough pellicle rising on the wall of the flask.

Acid from ethyl alcohol, propyl alcohol and glycol. No acid from arabinose, fructose, glucose, galactose, sucrose, maltose, lactose, raffinose, devtrin, starch, methyl alcohol, isopropyl alcohol, butyl alcohol, isobutyl alcohol, amyl alcohol, glycerin, mannitol and acetaldehyde (Henneberg, Die deutseb. Essigind. £, 1893. 147).

Acrobic.

Optimum temperature 31°C.

Habitat: Isolated from vinegar and

Acetobacter plicatum Fuhrmann.
 (Beiliefte 2. bot. Centrolbl., Orig., 19, 1905, 8) Description given in Cent. f.
 Bakt., II Abt., 18, 1906, 377. From plicatus, folded.

Rods: 0 55 to 0 7 by 0.75 to 0.9 microns when grown on agar at 25° to 30°C. Young streak cultures 0.4 to 0.6 by 1.4 to 1.6 microns with homogeneous staining when grown on beef-extract-gelatin at 22°C. 0 5 by 1.5 to 1.7 microns with unevea staining (polar) when grown on wine gelatin. At about 40°C the organisms form swollen and greatly elongated forms. Non-motile

Agar slant · Pale yellowish, translucent

growth.

Alcohol-free beer with glucese and sucrose Turbid with thick pellicles.

Potato: Growth limited.

Ferments alcohol to form acetic acid. Optimum temperature 28° to 30°C.

· Habitat : Wine.

5. Acetobacter acetigeaum (Henneberg) Bergey et al. (Bacterium acetigenum Henneberg, Cent f. Bakt, II. Abt., 4, 1898, 14; Bacillus acetigenum Migula, Syst. d. Bakt., 2, 1900, 801; Bergey et al., Manual, 1st ed., 1923, 35.) From Latin, producing vinegar.

Rods, occurring singly and in pairs. 0.8 to 1.2 by 1.2 to 1.4 microns. Motile. Cells give a cellulose reaction with II:SO: and iodine.

Glucose gelatin colonics: Raised, grayish, slimy.

Pluid cultures show a tough, slimy pellicle.

Acid from glucose, ethyl alcohol, propyl alcohol and glycol. No acid from arabinose, fructose, galactose, sorbose, sucrose, maltose, lactose, raffinose, dextrin, starch, glycogea, inulin, methyl alcohol, isopropyl nlcohol, butyl alcohol, isopropyl nlcohol, butyl alcohol, isobutyl alcohol, amyl alcohol, glycerol, erythritol, mannitol, dulcitol and acetal-dehyde (Ilenaeberg, Die deutsch. Essigind., £, 1898, 147).

Acrobic.

Optimum temperature 33°C. Thermal death point 43° to 45°C for 5 minutes.

Habitat: Vinegar.

6. Acetobacter industrium (Honneberg) Bergey et al. (Bacterium industrium Henneberg, Zeitschr, f. deutsche Essigindustrie, Berlin, 1898; Cent. f. Bakt., II Abt., 4, 1898, 933; Bacillus industrius Migula, Syst. d. Bakt., 2, 1909, 801; Bergey et al., Manual, 1st cd., 1923, 36.) From Latin industrius, diligent.

Rods 0.3 to 0.8 by 2.4 to 20 microns, occurring singly and in chains No distinct color produced with iodine.

Forms pellicle on fluid culture media. Acid from arabinose, fruetose, glucose, galactose, sucrose, maltose, lactose, rafinose, starch, dextrin, ethyl alcohol, propyl alcohol, glycol, glycerol and mannitol. No acid from isopropyl alcohol, butyl alcohol, isobutyl alcohol, amyl alcohol and acetaldehyde (Henneberg, Die deutsch. Essigind., 2, 1898, 147).

Aerobic.

Optimum temperature 23°C. Mavi mum 35°C. Minimum 8°C.

Habitat: Beer wort.

 Bacterium schuezenbachii Henneherg. (Die deutsche Essignid, No 11-18, 1906; also Cent i Bakt, II Aht, 17, 1906, 790.) Named for Schüzenbach, the inventor of the German quick vinegar process.

Rods: 03 to 0.4 by 10 to 3.6 merons, occurring singly, in pairs and chains. The cells are round, oval or elongated, not infrequently sickle-shaped or irregularly between with rounded or pointed ends. Not stained with iodine. Non-motile

Wort gelatia colonics Round, shiny, transparent with yellowish brown centers

A non-coherent film produced on the surface of liquid media

Acid from arabinose, fructose, glucose, glucose, galactose, maltose, lactose, doxtrn, ethyl alcohol, propyl alcobol, glycerol and crythritol. Small amount of acid from sucrose and ruffinose. No acid from mannitol (Henneberg, Handbuch d Garungshakt., § 1925, 293).

Temperature relations. Optimum 25° to 27.5°C. Scant growth at 34° to 35°C and 13° to 15°C. No growth at 37° and

7 5°C.
Source: Isolated from vinegar in the quick vinegar process

Habitat. Produces acetic acid in quick vinegar process

S. Bacterium xylinoides Hennehery (Die deutsche Essigind., No. II to 18, 1906; also Cent. f. Bakt., II Abt., 17, 1906, 791.) From Greek, woody.

Rods: 0 5 to 0.8 microns (round cells) and 0 5 to 1.2 microns (long forus), occurring singly, in pairs or chains, cells round and as short and long rods. The thick membrane like that produced by Acetobacter xylinum gives the reaction for cellulose with todane and sulfartie acid, but the thin membrane does not acid, but the thin membrane does not

Wort gelatin. Colonics are produced like drops of water, often with light brown kernels in the center.

Wort gelatin streak · Growth transparent at first, later whitish

Three types of membrane on fluid media are formed by this species and all three may even be found on a culture at one time. A thin, firm, coherent membrane like that of Bacterium ortennesse may be formed or one that is voluninous, scumilke (like coagulated egg-white), coberent, somewhat slimy and finally thick like that of Bacterium xylinum. Also a membrane may be formed that is intermediate in type.

Acid from arabinose, glucose, galactose, sucrose, maltose, ethyl alcohol, propyl alcohol, glycerol and erythritol. Small amount of acid from fructose and mannifol.

Temperature relations Optimum 25°C. Slight growth at 14°C No growth at 6°C

Source. Isolated from wine vinegar from the Rhine and other sections.

Habitat: Found in vinegar made by the Orleans method

9 Bacterium orleaneuse Henneherg. (Die deutsche Essignd, No. 11-18, 1906; also Cent. I Bakt., 17, 1906, 792.) Latinized, of Orleans.

Rods 0.4 to 0.5 by 1 2 to 2.1 microns, occurring singly or in chains. The cells are round, elongated or as involution forms, with atraight or curved cells appearing Not stained with iodine Non-mottle.

Wort gelatin. Colonies irregular in form, whitish in color, about 1 mm. in diameter in 2 days

Wort gelatin streak: Growth often slimy, transparent, liquid mass with vellowish brown sediment.

Wort agar streak: Some strains form isolated, mosts, slimy, transparent colonies and on the water of condensation isolated whitish colonies are formed Other strains form a coherent, transparent coating with a light brown precipitate later and individual, distinct, round colonies of the same color.

Characteristic of this species is the firm coherent film on the surface of liquid media. Acid from arabinose, glucose, galactose, maltose, lactose, raffinose, dectrin, ethyl alcohol, proppl alcohol, glycerol, erythritol and mannitol. Small amount of neid from fructose and sucrose (Henneberg, Handbuch d. Garnugsbakt., 2, 1920, 239).

Temperature relations: Optimum 20° to 30°C. Slight growth at 35° to 36°C and 14° to 15°C. No growth at 39° and at 7° to 8°C.

Source: Isolated from vinegar in the quick vinegar process.

Habitat: Can be used both in the quick or German process and the Orleans method of making vinegar.

Bacterlum vial acetati Henneberg.
 (Die deutsche Essigind, No. 11-18, 1906; also Cent. f Bakt., II Abt., 17, 1906, 797)
 From Latin vinum, wine and acetum, vincear.

Rods: 0 3 to 0 8 by 0.8 to 2.0 microns, occurring singly, in pairs and sometimes as short chains of three; cell round, oval or slightly clongated, and rarely moderately long forms. Streptococcus-like cells are found on older agar cultures and spindle forms in beer gelatin with 10 per cent sucross.

Wort gelatin: Round, moist, shiny, transparent colonies with whitish sediment in the center.

The film on liquid media is not strongly coherent and the liquid is cloudy.

Acid from arabinose, fructose, glucose, galactose, sucrose, maltose, milinose, dextrin, ethyl alcohol, propyl nlcohol, glycerol and crythritol. No acid from lactose (Henneberg, Handbueh d. Gärungsbakt., §, 1925, 239).

Optimum temperature 28° to 33°C

Source · Wine vinegar.

Habitat: Found in vinegar made by the
Orleans method for wine vinegar.

11. Bacterium curvum Heaneberg. (Die deutsche Essigind, No 11-18, 1906; also Cent. f. Bakt., II Abt., 17, 1906,

791 ) From Latin, curvus, bent. Rods: 0.4 to 0.5 by 2.0 to 2.4 microns. occurring singly or in pairs, cells usually oval or clongated, not infrequently sickleshaped, with rounded or pointed ends Not stained with iodine solution. Nonmotile.

Wort gelatin: Transparent, round colonies with raised center und edge, frequently whitish and dry.

A non-coherent scanty pellicle is formed on the surface of liquid media which sinks readily and the liquid is quite turbid.

Forms round white islands on the surface of wort with 3 per cent alcohol.

In old cultures on beer are to be found numerous smooth light brown raised colonies about 1 mm in diameter on the uniform transparent base of the surface membrane.

Acid from arabinose, glucose, raffinose, devtrin, ethyl alcohol, propyl alcohol, glycerol and crythritol. Small amount of acid from fructose, galactose and mannitol. No neid from sucrose, maltose and lactose (Henneberg, Handbuch d. Changabel, 4, 1003, 230).

Carungsbakt., 2, 1925, 239).
Temperature relations: Optimum 25° to 30°C. Scant growth at 16° to 17°C. No growth at 7° to 8°C. Growth at 35°C. No growth at 30°C.

Source: Isolated from vinegar in the quick vinegar process.

Habitat: Produces acetic acid in the

12. Acetobacter viscosum Shimmell (Bacterium aceti viscosum Day and Baker, Cent. f. Bakt., II Abt., 35, 1913, 433; Bacillus aceti viscosum Day and Baker, tbid., 437; Also see Baker, Day and Hulton, Jour. Inst. Brewing, —, 1912, 651; Shimwell, Jour. Inst. Brewing, 42 (N. S. 32), 1935, 556.) From Latu, viscous or sluw.

Rods: 0.4 by 1.2 microns which produce ropiness in beer. No capsules observed. Non-motile as a rule. Weakly Grampositive

Source: From ropy beer.

13 Acetobacter capsulatum Shimwell. (Jour. Inst. Brewing, 42 (N. S. 52), 1936, 585.) From Latin, capsulated.

Coccoid rods, 0 8 to 1 0 meron in malt extract media. 0 6 to 1 5 microns in other media. Produce ropiness in beer. Capsulated. Motile, Gram-negative.

Source: From ropy beer.

14 Acetobacter gluconicum (Hermann). (Bacterium gluconicum Hermann, Biochem. Zeit, 193, 1923, 195, also see Hermann, Biochem. Zeit, 205, 1929, 297 and Hermann and Neuschul, Biochem. Zeit, 233, 1931, 129)

It is unfortunate that an organism so well described must be placed with officer species of uncertain standing However, this organism is so closely related to the other organisms described in the literature that further study is necessary.

Source: From kombucha, a mixture of fungi and bacteria from tea infusions

15. Acetobacter turbidans Cosbie, Tošić and Walker, (Jour, Inst Brewing, 48, 1942, 82) This beer vinegar bacterium is characterized by the production of intense turbidity in beer and ale. The description given does not, at present, warrant recognition of the organism as a new species.

Source: From beer.

16. Bacterium dihydroxyacetonicum Virtanen and Bärlund. (Biochem, Zeit, 169, 1926, 170.)

There is no adequate description of this bacterium, and it is doubtful whether it can be properly evaluated since various species of Accidater also possess the ability to produce dihydroxyacetone from glycerol. Consideration of this as a momen rudem was indicated by Virtanen to Vaughn in a personal communication in 1938.

Source: From beet juico.

17 Actiobacter peroxydans Vissor te Hooft. (Inaug. Diss., Delft, 1925, 98) The exact taxonomo position of this bacterium will not be clear until further comparative studies have been made. Source From hydrogen peroxide solu-

Genus V Protaminobacter den Dooren de Jong.

tions.

(Bijdrage tot de kennis van het mineralisatioproces Thesis, Rotterdam, 1926, 159.) From M L, protamine and Latin, bactrum, rod

Cells motile or non-motile Capable of dissimilating alkylamins Pigmentation frequent. Soil or water forms

The type species is Protaminobacter albestavum den Dooren de Jong.

Key to the species of genus Protaminobacter.

I. Non-motile. Gelatin colonies light yellow to colorless.

1. Protaminobacter alboflavum

II. Motile Gelatin colonies red

2 Protaminobacter rubrum.

 Protaminobacter albofiavum den Dooren de Jong (Thesis, Rotterdam, 1926, 159; also see Cent. f Bakt, II

Abt , 71, 1927, 218.) From Latin albus, white; flavus, yellow.

Rede: Non-motile Green-persive

Bakt , II Rods Non-motile. Gram-negative

<sup>\*</sup> It is uncertain at present who first used this combination.

<sup>†</sup> Prepared by Prof. D. H. Bergey, Philadelphia, Pennsylvania, June, 1929; further revision by Prof. Robert S. Breed, New York State Experiment Station, Geneva New York, April, 1913.

Gelatin colonies: Circular, dry, light yellow or colorless.

Gelatin stab: No liquefaction.

Agar colonies: Circular, opaque, pigment bright red, yellow, light gray or coloriess.

Amine agar colonies: Circular, white to dark yellow.

See table below for list of organic substances utilized.  Protamiaobacter rubrum den Dooren de Jong. (Thesis, Rotterdam, 1926, 159; also see Cent. f. Bakt., II Abt., 71, 1927, 218.) From Latin, ruber, red.

Rods: Motile with single polar flagellum (Weaver, Samuels and Sherago, Jour. Bact., 55, 1938, 59). Gram-negative.

Gelatin colonies: Circular, red, dry. Gelatin stab: No liquefaction.

Table I.—Organic Substances Utilized as a Source of Carbon by Varieties of Protaminobacter alboflavum

| ORGANIC ACIDS  | a     | B   | 7 | 8 | ANINO CONFOUNDS   | a    | β          | γ   | 8   | AMINES      | α   | B   | 7   | 10 |
|----------------|-------|-----|---|---|-------------------|------|------------|-----|-----|-------------|-----|-----|-----|----|
| Acetie         | F     | +   | - | + | a alanın          | 7    | 0          | 1   | +   | Etbyl       | +   | +   | +   | 14 |
| Valerianic     | l + . | 1 + | 0 | + | α - aminocapronic | !    | <b>j</b> . | ľ.  | ] ] | Dietbyl.    | +   | I ∔ | 0   | 0  |
|                |       |     | i |   | aced              | +    | 0          | +   | 0   | Propyl .    | 1+  | 1+  | 1+  | 1+ |
| a-crotonie     | +     | +   | + | + | Leucin            | +    | +          | 0   | 0   | Isopropyl . | 0   | +   | 0   | 0  |
| Undecyclic     | 0     | 0   | 0 | + | Propionamid       | +    | 0          | +   | 0   | Dipropyl    | +   | +   | 0   | 0  |
| Lactic         | +     | 0   | 0 | + | Capronamid        | +    | 0          | +   | 0   | Tripropyl   | +   | 0   | 0,  | 0  |
| β-oxybutyric   | +     | + 1 | + | + | Uric scid         | +    | 0          | 0   | 0   | Buts1       | +   | 0   | +   | 0  |
| Succinic       | +     | +   | + | + | Hippune acid      | +    | 0          | 0   | 0   | Isobutyl .  | +   | +   | +.  | +  |
| Formic         | +     | +   | + | + |                   |      |            |     |     | Dilsobutyl  | +   | +   | 0   | 10 |
| Glutaric       | 0     | +   | 0 | + | ALCOROL           |      |            |     |     | Amyl        | +   | +   | +   | +  |
| Adipie         | 0     | 0   | 0 | + |                   |      | 1          |     |     | Diamyl      | 0   | +   | 0   | 0  |
| Fumario        | +     | +   | + | + | Ethyl             | 4    | 4          | +   | +   | Ethanol .   | +   | +   | +   | +  |
| Malic          | +     | + 1 | + | + | Luyi              | 7    | 7          | T 1 | T   | Glucceamin  | +   | +   | +   | 0  |
| Tartario       | 0     | +   | 0 | 0 |                   | - 11 |            |     |     | Benzyl      | +   | 0   | +   | 0  |
| Citric         | +     | +   | + | + | AUGAR             | - 1  |            |     |     |             | 1.4 | ш   | ш   |    |
| β-phenylpropi- |       |     |   |   |                   |      |            |     | - 4 |             | - 1 | ш   | ш   |    |
| onic           | +     | 0   | 0 | 0 | Glucose           | +    | +          | +   | 0   |             | ш   |     | . 1 |    |
| Quinic         | +     | +   | 0 | 0 |                   | - 1  |            |     | - 3 |             |     |     | -   |    |

Catalase is formed.

Aerobic, facultative.

Optimum temperature 30°C.

Habitat Soil and water.

Note: The author recognizes four varieties of this species which he differentiates on the basis of organe substances attacked (see Table) and pigment produced. Variety a shows light yellow growth on gelatin, bright red on agar and yellow on amine agar. Variety B is light yellow on gelatin, yellow on agar and dark yellow on a mane agar. Variety or is light yellow on gelatin, light gray on agar and yellow on amine agar. Vsriety 3 is coloriess on gelatin and agar and white on amine agar.

Agar colonies: Cırcular, red, opaque. Amine agar colonies: Circular, dark

The following organic acids are attacked: Acetic, lactic, \$\tilde{\text{posybutyric}}\$, glycerinic, succinic, malonic, formic, methyl formic, glutaric, maleinic, fumaric, malue, tartaric, citric and quinic.

The following amino compounds are attacked: Sarcosin, betain, hippuric acid, asparagine, propionamid, capronamid, lactamid, succinamid, allantoin and uric acid.

Glucose is fermented. Catalase is formed.

Aerobic, facultative.
Optimum temperature 30°C.

Habitat: Soil and water.

### Genus VI. Mycoplana Gray and Thornton.\*

(Cent. f. Bakt., II Abt., 75, 1928, 82.) From Greek, myles, fungus; plane, a wanderer or traveller.

Cells branching, especially in young cultures. Frequently banded when stained. Capable of using phenol and similar promatte compounds as a sole source of energy. Grow well on standard culture media.

Type species Mycoplana dimorpha Gray and Thornton.

#### Key to the species of genus Mycoplana.

- Gelatin not liquefied.
- II. Gelatia liquefied.

- 1. Mycoplana dimorpha.
- 2 Mycoplana bullata.

1. Mycoplana dimorpha Gray and Thornton. (Cent. f. Bakt., II Abt, 75, 1928, 82.) From Greek, ds. two; morphos, forms.

Short, curved and irregular cods, 05 to 07 by 1.25 to 4.5 roicrons, showing branching especially in young cultures Motile, with long polar flagella. Gramnegative.

Gelatin colonies : Circular, buff, smooth, resinous, entire.

Gelatin stab: No liquefaction. Geowth filiform. Agar colonies: Circular, buff, convex,

smooth, glistening, entire Agar slant: Piliform, white, convex, glistening, entire

Broth: Turbid, with surface ring

Nitrites not produced from nitrates but gas evolved in fermentation tubes Starch hydrolyzed.

No acid from carbohydrate media

Attacks phenol Aerobie.

Optimum temperature below 30°C Source: One atrain isolated from soil Rabitat: Probably in soil

2. Mycoplana bullata Gray and Thorn-(Cent. f. Bakt., II Abt., 73, 1928, 83) From Latin, bullatus, furnished will a boss or knob. Rods, curved and irregular, branching,

0.8 to 1 0 by 2 25 to 4 5 microns. Motile with polar flagella. Gram-negative. Gelatin colonies · Circular, buff, smooth, glistening, edge diffuse Partially lique. fied

Gelatin stab. Saccate liquefaction. Agar colonies: Circular, white, convex.

smooth, glistening, entire

Agar slant. Filiform, white, convex, smooth, glistening, entire.

Broth. Turbid Nitrates not produced from nitrates. Gas, presumably N. In lermentation

tubes.

Starch not hydrolyzed No acid from carbohydrate media.

Attacks phenol. Acrobic

Ontimum temperature below 30°C. Source Two strains isolated from soil.

Habitat: Probably in soil.

<sup>\*</sup> Prepared by Prof. D. H. Bergey, Philadelphia, Pennsylvania, June, 1929

f The original statements regarding the flagellation of these species are contradictory. The first reads "Polar, peritrichous, the second "Polar or peritrichous". Drawings given usually indicate peritrichous rather than polar flagellation. Further study is needed before these species can be properly placed in relation to other known species.-Editors

# TRIBE II. SPIRILLEAE KLUYVER AND VAN NIEL. (Cent. f. Bakt., II Abt., 94, 1936, 346.)

More or less spirally eurved cells.

#### Key to the genera of tribe Spirilleac.

- I. Generally motile by means of a single polar flagellum.
- A. Short, bent rods occurring singly or united into spirals.
  - Genus I. Vibrio, p. 192.
  - B. Slightly curved rods of variable length. Strict anaerobes which reduce sulfates to hydrogen sulfide.

Genus II. Desulfovibrio, p. 207.

- C. Cells ovidize cellulose forming oxycellulose. Growth on ordinary culture media is feeble.
  - Long, slightly curved rods with rounded ends.
    - Genus III. Cellvibrio, p. 209.
- 2. Short, curve-1 rods with pointed ends.

Genus IV. Cellfalcicula, p. 211.

II. Generally motile by means of a tuft of polar flagella. Cells of varying thick-

- ness, and length and pitch of spiral, forming either long curves or portions of a turn
  - A. Oxidize inorganic sulfur compounds. Cells contain free sulfur granules. Genus V. Thiospira, p. 212.
  - B. Not as above.

Genus VI. Spirillum, p. 212.

# Genus I. Vibrio Müller.\*

(Muller, Vermum terrestrium et fluviatilum, 1, 1773, 39; Pacinia Trevisan, Atti d. Accad Fisio-Medico-Statistica in Milano, Ser 4, 5, 1885, 53; Microspira Schroeter in Cohn, Kryptogamen-Flora von Schlesien, S, 1, 1886, 108; Pseudospira De Toni and Trevisan, Sylloge Fungorum, 8, 1889, 1018, Photobacterium Beijerinek, Arch. néerl. d. sci. exactes, 23, 1889, 401; Luquidovibrio Orla-Jensen, Cent. f. Bakt. II Abt., 22, 1909, 333; Solidovibrio Orla-Jensen, 1914; Dicrospira Enderlein, Sitzber. Ges naturi. Freunde, Berlin, 1917, 313) From Latin, 1916, vibrate.

Cells short, curved, single or united into spirals. Motile by means of a single polar fiagellum which is usually relatively short; rarely, two or three fiagella in one tuit. They grow well and rapidly on the surface of standard culture media. Acrobic to anaerobic soccies. Mostly water forms, a few parasites.

naerobic species. Mostly water forms, a few parasites.

The type species is Vibrio comma (Schroeter) Winslow et al.

Key to the species of genus Vibrio.

I. Gelatin liquefied.

- A. Nitrites produced from nitrates.
- Indole is formed.
  - a Milk not coagulated.
- Vibrio comma.
- 2. Vibrio berolinensis.
- aa. Milk coagulated.
- 3. Vibrio metschnikovii.

<sup>\*</sup> Revised by Prof D H. Bergey, Philadelphia, Pennsylvania, April, 1937; partial revision by Capt. Wm. C. Haynes, Sn.C., Fort Bliss, Texas, July, 1943 and by Lt. Col. A. Parker Hitchens, University of Pennsylvania, Philadelphia, Penna., December, 1943.

- Indole not formed.
  - a. Milk not coagulated.
- 4. Vibrio tyrogenus. 5. Vibrio zenopus.
- B. Nitrites not produced from mitrates,
  - 1. Indole is formed
    - a. Milk coagulated, peptonized 6 Vibrio piscium.
  - 2. Indole not formed.
    - a Milk acid, coagulated
      - 7 Vibrio proteus.
        - 8 Vibrio wolfis
        - 9. Vibrio sputigenus. 10 Vibrio liquefaciens
      - sa. Milk not cosgulated
        - b Growth on potato thin, barely visible 11. Vibran streetus.
        - bb No growth on potato
        - 12 Vibrio aquatilis
    - aza. Action on milk not reported b Acid from glucose Attacks naphthalene.
      - 13 Vibrio neocistes
      - bb No acid from carbohydrates Attacks naphthalene 14 Vibreo cuneatus
- bbb No acid from carbohydrates Liquefies agar 15 Vibreo granit
- II. Gelatin not housfied
- A. Nitrites produced from natrates
  - 1. Acid and gas from glucose
    - 16 Vibrio leonardii
  - 2. Acid but not gas from glucose Liquefies agar. 17 Vibrio agarliquefaciens
  - B. Nitrites not produced from nitrates 2. No acid from carbohydrates
    - I. Acid from glucose 18 Vibrio cyclosites
    - 19 Urbrig percolans
  - C Nitrite production not reported 1. Requires the addition of ammonium sulfate for growth Ammonium sulfate agar houefied.
    - 20 Vibrio andoi. 2. Do not require ammonium sulfate for growth
      - a Indole not formed
        - b. Microaerophilie, becoming aerobic. 21. Vibrio fetus
        - bly Acrobic, facultative 22 Vibrio pierantimii.
- 479: Spirillum cholerae aziaticae Zopl.
- 1. Vibrio comma (Schroeter) Winslon et al. (Kommalacillus, Koch, Berliner klin, Wochenschr , 21, 1881,
  - Die Spaltpilze, 3 Aufl , 1885, 69, Parinin choleraeasiaticae Trevisan, Atti d. Accad

Fisio-Med.-Statistica in Milano, Ser. 4, 5, 1885, 84; Microspira comma Schroeter, in Cohn, Kryptogamen Flora v. Schlesien, 5, 1, 1886, 103; Vibrio cholerae Neisser, Arch f. Hyg., 19, 1893, 199; Vibrio cholerae asiaticae Pfeiffer, in Flugge, Die Mikroorganismen, 2, 1896, 527; Winslow et al., Jour. Bact., 6, 1920, 201; Bacillus cholerae Holland, Jour. Bact., 6, 1920, 217; Bacillus comma Holland, ibid., 218; Spirillum cholerae-asiaticae Holland, ibid., 225; Vibrio cholerae-asiaticae Holland, ibid., 226.) From Latin, comma.

Slightly curved rods, 0.3 to 0.6 by 1 0 to 5.0 merons, occurring singly and in spiral chains. Cells may be long, thin and delicate or short and thick. May lose their curved form on artificial cultivation. Motile, possessing a single polar flagellum. Gram-negative.

Gelatin colonies: Small, yellowisb-

Gelatin stab: Rapid aapiform lique-

Agar colonies · Circular, whitish · brown, moist, glistening, translucent, slightly raised, entire.

Agar slant: Brownish-gray, moist, glistening.

McConkey's medium: Good growth, colonics colorless when young, soon pinkish, medium becomes darker red.

Broth: Slightly turbid, with fragile, wrinkled pellicle and flocculent precipitate.

Peptone water: Characteristic rapid growth, chiefly at surface, where after 6 to 9 hours, a delicate membrane is formed; little turbidity, deposit apparently derived from pellicle (Topley and Wilson, Princip. Bact and Immun., 2nd ed., 1936, 388) Readily isolated from the surface film of 0.1 per cent peptone water.

Litmus milk Alkaline at the top and slightly acid at bottom; generally not coagulated; peptonized; reduced Potato: Dirty-white to yellowish, moist, . glistening, spreading.

Blood serum: Abundant growth, sometimes slow liquefaction,

Blood agar: The blood pigment is digested forming a greenish zone around colonies; a true soluble hemolysin is not formed (the El Tor vibrio also digests blood pigment but in addition produces a soluble hemolysin. Otherwise it is said to be indistinguishable from the typical cholera vibrio).

Indole is formed. Nitrites produced from nitrates.

Cholera-red reaction, which depends on production of indolo and reduction of nitrates is positive.

Hydrogen sulfido is formed.

Acid but not gas from glucose, fructose, galactose, maltose, sucrose and mannitol. Slowly from glycerol. Does not attack lactose, inulin or dulcitol.

Group I of Helberg (Classification of Vibrio cholerae and Cholera-like Vibrios. Copenhagen, 1935) ferments mannose and sucrose but not arabinose.

Hydrolyzes starch actively in alkaline media.

High alkali but low acid tolerance; optimum pH 7.6 to 8.0; for isolation on Dieudonne's medium pH 9.0 to 9.6.

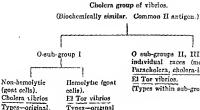
Aerobic, grows best in abundant ovygen; under strict anaerobiosis may fail to grow altogether.

Optimum temperature 37°C. Maximum 42°C. Minimum 14°C.

Source: From intestinal contents of cholera patients in Egypt and India

Habitat: Intestinal contents of cholers patients and earriers.

The relationships existing among the cholerigenic and non-pathogenic water vibrios, although studied intensively, have not yet been completely defined. As a working scheme, based on somatic (O) and flagellar (H) antigen studies, Gardner and Vankatraman (Jour. Ilys, 55, 1935, 262-282) suggest the following



and variant

(?middle)

Linton (Bact. Rev., 4, 1949, 275) has outlined a classification of the vibrios based upon their protein and polysaccharide structures Using chemical methods, it was found that one polysaccharide and one protein was commonly obtained from cach strain of vibro; when exceptions occurred, it was invariably noted that the strain was undergoing dissociation. Given a single protein and polysaccharide in each vibrio, it was possible to divide the strains into six groups, which were numbered in the order of their discovery as shown in the table

variant and

middle

A chemical grouping of the cholerigenic and uater vibrios

| Group | Protein Type | Polysaccharide<br>Type |  |  |  |  |
|-------|--------------|------------------------|--|--|--|--|
| 1     | 1            | I                      |  |  |  |  |
| 11    | 1            | 11                     |  |  |  |  |
| 111   | II           | 11                     |  |  |  |  |
| IV    | 11           | 1                      |  |  |  |  |
| v     | II           | III                    |  |  |  |  |
| VI    | 1            | III                    |  |  |  |  |
|       |              |                        |  |  |  |  |

The strains of Groups I and II possess the same protein and different polysaccharides. These are derived from cases of cholera and have the serological

O sub-groups II, III, IV, V, VI and individual races (mostly hemolytic). Paracholera, cholera-like, and some El Tor vibrios.

(Types within sub-groups underlined )

and brochemical characteristics of O. Group I, Vibrio cholera. Group I strains are more common than those of Group II. which have, however, been isolated from epidemics with a high mortality. The phospholipid fraction is common to both types when isolated in the early part of an epidemic, but is not found in strains of other groups. The harmless water vibrios, which are so heterogeneous scrologically (Taylor and Ahula, Indian Jour. Med Res., 26, 1933, 8-32) form a single chemical group with a homogeneous structure. They fall into Group III, which differs in its protein structure from the authentic cholera vibrios, and resembles Group II in its polysacchande The vibries of Group IV, which came from El Tor and from chronic vibrio carriers are believed on epidemiological grounds to be harmless. although serological methods have failed to distinguish them from cholerigenic vibries Group V, which, like III and IV, contains protein II, consists, like Group IV, of strains from chronic vibrio carners. Group VI strains are only rarely isolated in nature and representatives of this group are generally found among collections of old laboratory strains They appear to be the result of polysaccharide variation from Group I

after long-continued growth on artificial media.

2 Vibrio berolinensis Neisser. (Arch. Hyg., 19, 1893, 200; Microspita berolinensis Migula, in Engler and Pranti, Die naturi. Pflanzenfam., 1, 1a, 1895, 33.) From M. L., the genitive of Berolina, the Latin name for Berlin.

Curved rods, somewhat smaller than Vibrio comma. Frequently occurring in pairs. Mottle, possessing a polar flagellum Pleomorphie. Gram-negative.

Gelatin colonies: Small, grayish, slightly granular, fragmented.

Gelatin stab: Slow, napiform liquefaction.

Agar slant: Grayish-yellow, moist.

glistening

Broth: Turbid, with gray pelliele. Litmus milk No coagulation, no acid.

Potato: Brownish streak.

Indole is formed

Nitrites produced from nitrates.

Not pathogenic for mice, pigeons or guinca pigs.

Aerobic, facultative.

Optimum temperature 37°C Minimum above 10°C. Maximum less than 60°C.

Source · Isolated from filtered Spree river water.

3. Vihrlo metschnikovil Gamaléia. (Gamaléia, Ann. Inst Pasteur, 2, 1883, 482; Pacanna metschnikofi Trevisan, I generi e le specie delle Batteriacee, 1889, 33; Sprullum metschnikosi Sternherg, Man of Bact., 1893, 511, Vibrio nordhafen Pfuhl, Ztschr f Hyg, 22, 1894, 234; Microspira metschnikofii Migula, in Engler and Pranti, Die naturi Pflanzenfam f., 1a, 1895, 33.) Named for Metschnikofi, Russian bacteriologist.

Probable synonyms Vibrio schuylkiliensis Abbott, Jour. Exp Med. 1, 1896. 424 (Microspira schuylkiliensis Chester, Manual Determ. Bact., 1901, 334); Vibrio danubicus Heider, Cent. f. Bakt., 14, 1893, 341 (Microspira danubica Migula in Engler and Prantl, Die natürl. Pflanzenfam., 1, 1a, 1895, 33; Spirillum danubicum Holland, Jour. Baet, 5, 1920, 225).

Curved rods, somewhat shorter and thicker than Vibrio comma. Motile Gram-negative.

Gelatin colonies: Like those of Vibrio

Gelatin stab: Rapid, napiform liquefaction.

Agar slant: Yellowish, plumose, moist, glistening.

Broth: Turbid, with thin, white pel-

Litmus milk: Acid, coagulated (eighth day); not peptonized.

Potato: Delicate, brownish growth.

Indole is formed. Nutrites produced from nitrates.

Pathogenic for pigeons, fowls, and guinea pigs.

Aerobic, facultative.

Optimum temperature 37°C. Maximum less than 45°C.

Source Isolated from fowl dead of a cholerous disease.

Habitat: The intestinal contents of chickens, pigeons and other animals suffering from a cholera-like disease.

4 Vibrio tyrogenus (Flügge) Holland (Käsespirillen, Deneke, Deutschmed. Wechnehr., H., 1885, 33; Spirillem tyrogenua Flugge, Die Mikroorganismen, 2 Aufl., 1886, 386; Paenna denekei Trevisan, I genen e le specie delle Batteriscee, 1889, 23; Microspira tyrogena Migula, in Engler nnd Franti, Die naturl. Pflanzenfam., I, 1a, 1895, 33; Holland, Journater, δ, 1920, 225, Vibrio denekit Hauduroy et al., Diet. d. Bact. Path, 1837, 511.) From Greek tyros, cheese, genes, produced from.

Curved rods, rather smaller and more slender than Vibrio comma, often very long, closely wound spirals Motile, possessing a polar flagellum. Gramnegative Gelatin colonies: Small, gray, granular, entire.

Gelatin stab Rapid, saccate hquefaction Agar slant: Yellowish-white, plumose,

glistening.

Broth: Turbid. Litmus milk: Not congulated

Potato: No growth.

Indole not formed. Slight production of nitrites from

nitrates.

Aerobic, facultative. Optimum temperature 30°C

Source. Isolated from cheese

5 Vibrio xenopus Schrire and Greenfield (Trans Royal Soc So Africa, 17, 1930, 309.) From Xenopus, a genus of African toads.

Spiral forms, occurring singly and in pairs. Non-motile. Gram-negative Gelatin stab: Slow, crateriform lique-

faction.

Agar colonies: Small, white, glistening,

slimy, entire.

Agar slant. Grayish-white, slimy,

entire.

Bmtb: Turbid with flocculent sediment.

Latmus milk: Unchanged.

Potato: Not reported. Indole is not formed

Nitrites are produced slowly from nitrates.

Blood serum is peptonized Starch is not hydrolyzed.

Acid from glueose, fruetose, maltose,

glycerol and sorbitol.

Aerobic, facultative.

Optimum temperature 37°C.
Source: Found in abscess of pectoral

muscle of African toad.

6. Vibrio pisclum David. (Cent. f.

Bakt., I Abt., Orig , 102, 1927, 46.) From Latin piscus, fish

Curved rods: 0.3 to 0 5 by 2 0 microns. Motile with a single polar flagellum. Gram-negative. Gelatin colonies: Circular, granular, paque Gelatin stab: Napiform liquefaction.

Agar colonies: Yellowish, carcular, smooth, entire, indescent.

Agar slant · Light yellow, transparent streak.

Broth: Slight turbidity, with thin pellucle.

Litmus milk: Soft coagulum. Peptonized, alkaline.

Potato: Brownish-red streak

Indole is formed

Nitrites not produced from nitrates.

Hydrogen sulfide formed. No action in sugar media.

Pathogenic for frogs.

Aerobic, facultative,

Optimum temperature 18° to 20°C. Habitat Causes epidemic infection in fish.

7. Vibrlo proteus Buchner (Kommabacilius der cholera nostras. Finkler and Prior, Deutsche med Wochenschr., 1834, 632; Buchner, Sitzungsber, d Gesel, f Morph u. Physiol., Munchen, Heft 1, 1885, 10; Pacinia finkleri Trevisan, Attı d. Accad. Fisio-Medico-Statistica in Milano, Ser. 4, 3, 1885, 84; Microspira finkleri Schroeter, in Cohn, Krytogamen-Flora von Schlesien, 3, 1, 1886, 168, Spirillum finkleri Crookshank, Man, of Bact , 3rd ed., 1890, 282; Microspira protea Chester, Manual of Determinative Bacteriology, 1901, 338, Vibrio finkleri Holland, Jour Baet., 5, 1920, 225.) From Greek, Proteus, a marine derty who had the power of assuming any shape he chose. Curved rods: 0.4 to 0 6 by 2.4 microns.

often pointed at both ends Mottle, possessing a polar flagellum. Gramnegative

Celatin colonies · Small, gray, circular, granular, entire

Gelatin stab: Itapid, saccate liquefaction.

Agar slant: Dirty grayish, plumose. Broth: Turbid, with fetid odor.

Litmus milk : Slightly acid; cosgulated; pentonized.

Potato: Grayish, slimy layer.

Indole not formed.

Nitrites not produced from nitrates. Aerobie, facultative.

Optimum temperature 30°G. Source: Isolated from feces of pa-

tients suffering from cholera nostras.

Habitat: Intestinal contents in cholera nostras and cholera infantum.

8. Vibrlo wolfil (Migula) Bergey et al. (Bacillus choleroides Wolf, Münch, med. Wochenschr. 40, 1893, 693; Microspira wolfii Migula, Syst. d. Bakt., 2, 1900, 1001; not Microspira choleroides Migula. loc. cit , 992; Bergey et al., Manual, 1st ed., 1923, 80 ) Named for Wolf, who first isolated this organism.

Gurved rods and S-shaped forms.

Motile. Grom-negative Gelatin colonies: Small, grayish-white,

spreading Gelatin stab. Infundibuliform lique-

faction. Agar slant: Gray, moist layer. Broth: Turbid, with gray pelliele Litmus milk: Acid; coagulated.

Potato Yellowish-white layer. Blood serum: Rapid liquefaction.

Indole not formed. Nitrites not produced from nitrates.

Aerobic, facultative. Optimum temperature 37°C.

Source: Isolated from cervical secretions in chronic endometritis.

9. Vibrio sputigenus (Migula) Bergev et al. (Vibrio aus Sputum, Brix, Hyg. Rundschau, 4, 1894, 913; Microspira sputigena Migula, Syst. d. Bakt., 2, 1900. 981; Bergey et al , Manual, 1st ed., 1923. 80.) From Latin, spuo (sputus), sputum; -genes, produced from.

Slightly curved rods, about the same size and form as Vibrio comma, occurring singly, occasionally three or four in a chain. Motile. Possessing a polar flagellum. Gram-negative.

Gelatin colonies: Small, circular. slightly gronular, yellowish, becoming

brownish. Gelatin: Groteriform liquefaction.

Agar slant: Gravish-white, moist, Broth: Turbid, no pellicle formed. Litmus milk: Acid: coagulated.

Potato: Thin, groy layer, spreading. Indole not formed.

Nitrites not produced from nitrates.

Aerobic, facultative. Op!imum temperature 37°G. Source: Isolated from sputum.

10. Vibrio liquefaciens (Migula) Bergey et al. (Bonhoff, Arch. f. Hyg., 19, 1893, 218; Microspira liquefaciens Migula, Syst. d. Bakt., 2, 1900, 990; Bergey et al., Manual, 1st ed., 1923, 81.) From Latin, liquefacio, to make liquid.

Comma and S-shaped rods. Motile. Gram-negative.

Gelatin colonics: Circular, with ir-

regular margin, surrounded by a rosecolored zone.

Gelatin stab: Slow, napiform lique-

Agar slant: Smooth, groyish, plumosc. Broth: Turbid, with heavy grayish pelliele.

Litmus milk: Acid: coagulated. Potato: Moist, brownish layer.

Indole is not formed. Nitrites not produced from nitrotes.

Aerobic, facultative, Optimum temperature 37°G.

Habitat: Water.

(Ztschr. 11 Vibrio strictus Kutscher. f. Hyg., 19, 1895, 469.) From Latin

stringo (strictus), constricted. Markedly curved rods, of about twice the size of Vibrio comma. Motile.

Grom-negative. Gelatin colonies: Small, circular, yel-

lowish, with serrate margin. Gelatin stab: Slow, napiform to sac-

cate liquefaction. Agar slant: Growth plumose, moist

Broth: Turbid, with gray pellicle.

Litmus milk: Not coagulated. Potato: Thin, barely visible layer. Blood serum is slowly liquefied. Indole is not formed.

Nitrites not produced from nitrates. Pathogenic for guinea pigs.

Aerobic, facultative. Optimum temperature 37°C.

Habitat: Water.

12 Vibrio aquatilis Günther. (Deutsche med. Wochenschr., 1892, 1121; Microspira aquatilis Migula, System der Bakterien, 2, 1900, 993.) From Latin, aquaticus, living in water

Curved rods, like Vibria comma Motile, possessing a polar flagellum Gram-negative.

Gelatin colonies: Circular, brownish,

finely granular, entire

Gelatin stab: Crateriform liquefaction Agar slant: Moist, gmyssh, glistening

Bmtb: Slightly turbid. Litmus milk: Not coagulated

Potato · No growth Indole not formed Nitrites not produced from nitrates

Aembic, facultative Optimum temperature 30°C

Habitat: Water.

13. Vibrio neocistes Gray and Thorn. ton. (Gray and Thornton, Cent Bakt , II Abt., 73, 1928, 92 ) From Greek nees, new and kiste box or ark Here used as the equivalent of Newark, the name of a city in England

Curved rods, 05 to 10 by 10 to 40 microns. Motile with one to three polar flagella. Gram stain not recorded. Gelatin colonies: Liquefied

Gelatin stab : Liquefied. Medium red-

Agar colonies: Circular or amoeboid, buff to brownish, convex, smooth, glastening, entire.

Agar slant .Filiform, fluorescent, raised, smooth, glistening, undulate.

Broth: Turbid.

Nitrites not produced from nitrates Starch not hydrolyzed.

Acid from glucose. Attacks naphthalene. Aecobic, facultative. Optimum temperature. Habitat: Soil.

14 Vibrio cuneatus Gray and Thornton. (Gray and Thornton, Cent. f. Bakt., II Abt., 73, 1928, 92.) From Latin. cuneo (cuneatus) wedge.

Curved rods: 1 0 by 1.0 to 3 0 microns, the cells tapering at one extremity. Motile with one to five polar flagella. Gram-negative.

Gelatin colonies: Liquefied.

Gelatin stab: Liquefied

Agar colonies: Circular to amoeboid. white to buff, flat to convex, smooth, tmnslucent, border entire.

Agar slant: Filiform, whitish, smooth, glistening.

Indole not recorded.

Nitrites not produced from nitrites Starch not hydmlyzed

No acid from earbohydrate media.

Attacks naphthalene

Aembie, facultative

Optimum temperature 30° to 35°C. Source: One strain isolated from soil from Rothamsted, England. Habitat Soil

15 Vibrio granii (Lundestad) Stanier. (Bacterium granii Lundestad, Cent. f. Bakt., II Abt., 75, 1928, 330; Achromobacter granss Bergey et al., Manual, 3rd ed , 1930, 222, Stanier, Jour. Bact , 42, 1941, 538 ) Named for Prof H. H. Gran, who first detected agar-hquefying bacterra. Rods 06 to 08 by 14 to 24 microns,

with counded ends, occurring singly, in mairs, and at times in short chains. Motile. Polar flagellate (Stanier, loc. cit.). Gram-negative.

Fish-gelatin colonies: Punctiform, black, glistening.

Fish-gelatin stab: Slow, crateriform lieucfaction.

Sea-weed agar colonies: Circular, flat.

opaque, glistening, white, slimy, entire. Agar is dissolved.

Fish-agar slant. I'lat, white, elevated, glistening, undulate. Liquefied.

glistening, undulate. Liquefied.

Broth: Turbid with grayish-white,
slimy sediment.

Indole not formed.

Nitrites not produced from nitrates. Starch usually hydrolyzed.

No action on sugars.

Aerobie, facultative.

Optimum temperature 20° to 25°C. Source: Sea water of Norwegian Coast.

Source: Sea water of Norwegian Coast.
Habitat: Presumably sea water and
on sea weeds

16. Vibrio leonardii Métainikov and Chorine. (Ann. d. l'Inst Pasteur, 42, 1928, 1647) Named for Leonard.

Curved rods with rounded ends, 0.5 to 1.0 by 2.0 to 3.0 microns. Motile with I to 3 polar flagella. Gram-negative. Gelatin stab. No liquefaction.

Agar colonies Small, transparent, circular, having a characteristic odor.

Broth. Turbid, with thin pellicle.
Litmus milk No congulation, acid.

with reduction of litmus.

Potato Slight, colorless growth

Indole not formed Nitrites produced from nitrates

Blood serum not liquefied Hydrogen sulfide formed.

Acid and gas from glucose, fructose, galactose, lactose, sucrose and mannitol. No acid or gas from maltose or glycerol. Acrobic, facultative

Optimum temperature 30°C

Habitat: Highly pathogenie for insects as Galleria mellonella L. (bee moth), and Pyrausta nubialis Hübn. (European corn borer).

17. Vibrio agarliquefaciens (Gray and Chalmers) Bergey et al. (*licrospira agar-liquefaciens* Gray and Chalmers, Ann. Appl Biol., 11, 1924, 325; Manual, 4th ed, 1934, 119.) From Latin, *liquefacio*, liquefying; Malay, agar, a jelly from seaweeds.

Short curved rods, usually e-shaped,

with occasional s-shaped and coccoid forms. Cells 20 microns long by 0.5 to 0.7 micron broad; 3.0 to 50 microns long in division stages. Coccoid forms stained, 0.5 to 0.7 micron long. Mottle with a single polar flagellum. Gramstain not reported.

Gelatin stab: Very slight surface growth after one month; the streak then shows a beaded line. No liquefaction.

Agar colonies: Surface colonies appear as a whitish growth in a depression, surrounded by a white ring. The colony is later surrounded by a ring of liquid agar. Deep colonies show a clear area and may be irregular, oval or angular.

Agar slant: A deep groove is cut along the inoculation streak, whitish growth along sides. The gel is later much weakened.

Broth: Slightly turbid. No pellicle.
Acid from glucose, lactose and maltose. No acid from sucrose or glyceine.
Htilizes ammonia salts as a source of

nitrogen.

Decomposes cellulose and agar. The presence of one per cent glucose pre-

vents the liquefaction of agar.
Nitrites produced from nitrates.

Starch is hydrolyzed.

Acrobic.

Temperature relations: Optimum 25° C., will grow at 16° but not at 34°C. Habitat: Soil.

Vibrio eyclosites Gray and Thornton. (Gray and Thornton, Cent. für Bakt., II Abt., 75, 1925, 92.) From Greek kyklos, eirele or ring; siliö, to eat; M. L. cyclosiles, feeding on rings, i.e. ring compounds.

Curved rods: 0.5 to 1.0 by 1.5 to 40 microns. Motile with a single polar flagellum. Gram-negative.

Gelatin colonies: Circular, buff to brown, flat, smooth, glistening, entire. Gelatin stab: No liquefaction.

Agar colonies: Circular to irregular, pale buff (later greenish), smooth, entire.
Agar stab: Filiform, greenish buff, raised, smooth, undulate.



Potato · No growth.

Indole not formed.

Nitrite production not reported.

Blood serum slant: Feeble growth. No liquefaction.

No gas from earbohydrates. No change or slightly acid from glucose, lactose and sucrose.

Optimum temperature 37°C. Withstands 55°C for 5 minutes.

Aerobic or microacrophilic

Pathogenesis Causes abortion in cattle. Source Twenty-two strains isolated from the placentas or fetuses of cows having abortion.

Habitat · Causes abortion in cattle

Vibrio pieractonii (Zirpolo) Meissner. (Bacillus pierantonis Zirpolo, Boll. Soc. nat. Napoli, 30, 1918, 205; Meissner, Cent. f Bakt., II Abt., 67, 1926, 200.)
 Named for Pierantoni, nn Italian bacteriologist

Rods 9 5 by 1 5 microns, with rounded ends. Motile with one to three polar flagella Gram-negative

Gelatin colonies Circular, and irregu-

larly lobulate

Gelatin stab · No liquefaction

Agar colonies: Circular, light green, smooth, entire

Glycerin agar slant. Slightly luminous streak.

Broth · Turbid, with pellicle Indole not formed

Acid from glucose and maltose. Some strains also attack lactose, sucrose and mannitol.

Best growth in alkaline media

Aerobic, facultative

Optimum temperature 37°C.

Source: Isolated from the photogenie organ of the cephalopod Sepiola intermedia Nací

Appendix:\* The following species have also been listed in the literature. Many are inadequately described Microspira bonhoffii Migula. (Bonhoff, Arch. f. Hyg., 19, 1893, 252; Migula, Syst. d. Bakt., 2, 1900, 1008.) From water.

Microspira canalis Migula. (Spirillum saprophiles \( \gamma\) and Vibrio saprophiles \( \gamma\) Weibel, Cent. f. Bakt., \( \gamma\) 1837, 469, Migula, Syst. d. Bakt., \( \gamma\), 1837, 469, Migula, Syst. d. Bakt., \( \gamma\), 1900, 1001; Microspira cloaca Chester, Man. Determ. Bact., 1901, 341.) Possibly identical with Microspira saprophiles Migula, Microspira weibelii Migula, Vibrio surati Ford, Vibrio smithii Ford. From sewage. Microspira coprophila Migula. (Group 3, No. 6, Kutscher, Ztschr. f. Hyg., 19,

Microspira maasci (v. Hoff) Migula (Spirillum maasci v. Hoff, Cent. f. Pakt, I Abt., 21, 1897, 797; Migula, Syst. d. Bakt., 2, 1900, 978.) Possibly a variely of Vibrio comma Winslow et al. From

1895, 475; Migula, Syst. der Bakt., 2, 1900, 986) From fecal matter.

Rotterdam tap water.

Microspira milleri Migula. (Miller, Deutsche med, Wchnschr., 11, 1885, 188; Migula, Syst. d. Bakt. 2, 1909, 981; Spirillum milleri Holland, Jour. Bact., 5, 1920, 225; Yibrio milleri Holland, bid.) Probably identical with Vibrio protess according to Migula. From dental caries

Microspira murmanensis Issatchenko. (Recherches sur les microbes de l'océan glacial arctique (in Russian), Petrograd, 1914, 240) From sea water.

Microspira saprophiles Migula. (Heuvibrio B, Weibel, Cent. f. Bakt., 2, 1837, 409, Tebrio saprophiles B Weibel, Cent. f. Bakt., 4, 1888, 225; Migula, Syst. d. Bakt., 2, 1900, 1005; Microspira weibel Chester, Man. Determ. Bact., 1901, 220.) Probably identical with Microspira clora Chester and Vibrio surati Ford. From sewage.

Microspira tyrosinatica Beijerinck. (Kon. Akad Wetenschappen, Amsterdam, 13, 1911, 1068.) From sewage

Microspira weibelii Migula. (Vibrio

Prepared by Mr. Wm. C. Haynes, New York State Experiment Station, Geneva, New York, Jan \(\chi\) 1939; Revised by Capt. Wm. C. Haynes, Sn. C., Fort Bliss, Teus, July, 1943.

aaprophiles a Weibel, Cont. f. Bakt. 2, 1887, 465; ibid., 4, 1888, 225; Migula, Syst. d. Bakt. 2, 1900, 1005, Microspra saprophile Chester, Manual Determ Bact., 1901, 311; Vibrio saprophiles Ford, Texth. of Bakt., 1927, 365 | Possibly identical with Microspira cloaca Chester, Vibrio surali Ford, Vibrio surali Ford, Vibrio smithii Ford From sewage.

Spirillum lipoferum Beyernel. (Cent. I. Bakt., 11 Abt., 03, 1925, 333; (Aromatium lipoferum Bergey et al., Manual, 3rd ed., 1930, 531.) From garden earth and sewage Gesberger (Belittige zur Kenntnis der Gattung Spirillum Ebbg., Inaug Drss. Delft. 1936, 64) regards this organism as a Vibrio. Has a single polar flagellum

Spirillum nasıcola Trovisan (Nasenschleimvibro, Weibel, Cent f Bakt, 2, 1837, 465; Trevisan, I generi e le specie delle Batteriacce, 1889, 24, 1'bronazalıs Eisenberg, Bakt, Diag, 3 Auf, 1891, 212; Spirillum nasale Sternberg, Man of Bact., 1803, 697; Spirosoma nasale Migula, in Engler and Prantl. Die naturi. Pflanzenfam 1, 1 a, 1805, 31.) From human nasal mucus.

Spirillum parvum Esmarch. (Cent f Bakt., I Abt., Orig., 22, 1902, 585, also see Zettnow, ibid., 78, 1916, 1, Vibrio parvus Lehmann and Neumann, Bakt Diag., 4 Aufl., 2, 1907, 494) From de-

caying organic matter.

Vubrio albensis Lehmann and Neumann (Elbe vibrio, Dunbar, Deutselmed. Wochnschr., 19, 1863, 799, Lehmann and Neumann, Batt. Ding, I Auf., 2, 1896, 349; Microspira dunbars Migula, Syst. d. Bakt., 2, 1909, 1913; Photospirallum dunbar Miguel and Cambier, Trauté de Bact, Paris, 1902, 881; Photobacterium dunbar i Ford, Texth, of Bakt., 1927, 621) From water of the river Elbe. Phosphorescent

Vibrio amylocella Gray. (Canad Jour-Res, 17, 1939, 151) Decomposes cellulose. Produces glucose from starch. From soil.

Vibrio anguillarum Bergman. (Ber. a. d. k. Bayr. Biolog. Versuchstat., Mün-

chen, 2, 1909.) From an infectious discase of cels.

Vibrio aureus Weibel. (Weibel, Cent I. Baht., 4, 1888, 225, 257, 281; Spirillum aureum Trevisan, I generi e le specie delle Batteriacec, 1889, 24, Spirillum aureum Sternberg, Man of Bact., 1893, 700, Spirosoma aureum Migula, Syst. d., Bakt., 2, 1909, 958) Possibly identical with Vibrio flavus Weibel and Vibrio flavescens Weibel. From sewage.

Vibrio beijerinckii Stanier, (Jour. Bact, 42, 1941, 527-554.) Marine agar-

digesting vibrio.

Vibrio buccalis Prévot (Vibrion B, Repaci, Compt. rend. Soc. Biol., Paris, 1909, 630; Prévot, Man de Classif. des Bact. Anaér., Paris, 1940, 82) Anaerobe From the buccal cavity.

Vibrio bulbosa Kalniņš (Latvijas Ūniversitātes Raksti, Senja I, No. 11, 1930, 237.) Decomposes cellulose From

fioa

Vibrio cardii Klein (Cent f. Bakt., I Abt, Orig, 38, 1905, 173) Possibly debtical with Vibrio cuneatus Gray and Thornton and Vibrio marinus Ford. From the mussel (Cardium edule)

Vibrio castra Kalniņš (Latvijas Ūniversitātes Raksti, Serija I, No. 11, 1930, 241.) Decomposes cellulose From soil. Vibrio choleroides α and β Bujwid.

(Cent f Bakt, 13, 1893, 120; Microspira cholcroides Migula, Syst. d. Bakt, 2, 1900, 992) Probably a less vigorous strain of Vibro comma Winslow et al. according to Chester, Man Determ Bact, 1901, 337. From water

Vibrio chrysanthemoides Lehmann and Neumann. (Spirillum-like organism, Jones, Cent f. Bakt., II Abt., 14, 1904, 459, Lehmann and Neumann, Bakt. Diag., 4 Ault., \$, 1907, 493.) From five samples of tap water and sewage.

Vibrio crassus (Veillon and Repaci)
Prévot (Spirillum crassum Veillon and
Repaci, Ann Inst. Past., 20, 1912, 300;
Prévot, Man. de Classif des Bact. Anaér.,
Paris, 1940, 85.) Anaerobe From the
buccal cavity.

Vibrio crassus var. D, Prévot. "

D, Repaci, Ann. Inst. Past., 26, 1912, 550; Prévot, Man. de Classif. des Bact. Anaér, Paris, 1910, 86.) Anaerobe. From the buccal cavity.

Vibrio crasteri Hauduroy et al. (Craster, in Violle, Le Choléra, Masson édit, 1919, Hauduroy et al., Diet. d. Bact. Path., 1937, 541.) Isolated from healthy persons. Resembles Vibrio comma.

Vibrio cucumis Kalniņš. (Latvijas Ūniversitātes Raksti, Serija I, No 11, 1930, 243.) Decomposes cellulose. From soil.

Vibrio devorans Beijerinek. (Cent. f. Bakt, II Abt., 11, 1903, 598) From water.

Vibro drennan, Chalmers and Waterfield. (Drennan, Jour. Inf. Dis., 14, 1914, 251; Chalmers and Waterfield, Jour. Trop. Med., 19, 1916, 165.) Colonies white, turning dark brown. From fecees.

Vibrio flarescens Weibel. (Cent. f. Bakt., 4, 1888, 225, 257, 281; Spirillum flavescens Trevisan, I generie le specie delle Batteriacee, 1889, 24, Spirillum flavescens Sternborg, Man. of Bact., 1893, 700; Spirosoma flarescens Migula, Syst. d. Bakt., 2, 1900, 959) Possibly identical with Vibrio aureus Weibel and Vibrio flavus Weibel From sewage.

Vibrio flavus Weibel. (Cent. I. Bakt, 4, 1888, 225, 257, 281, Spirillum flavum frevisan, I generie le spoeie delle Batteriacce, 1889, 24; Spirillum flavum Sternberg, Man of Bact, 1893, 700; Spiriosoma flavum Migula, Syst. d. Bakt., 2, 1900, 950) Possibly identical with Vibrio aureus Weibel and Vibrio flarescens Weibel. From sewage

Vibrio fuscus Stanier (Jour. Bact., 42, 1941, 540.) Marine agar-digesting vibrio

Vibrio gauducheau Hauduroy et al. (Gauducheau, in Violle, Le Cholfera, Masson édit., 1919; Hauduroy et al., Diet. d. Bact., 1937, 543.) From the blood of a fever patient. Resembles Vibrio comma.

Vibrio ghinda Pfeisser. (Pasquale,

Gior. med. d. r. esercito, 1891; Pfeiffer, in Flugge, Die Mikroorganismen, 2, 1896, 590; Microspira ghinda Migula, Syst. d Bakt., 2, 1900, 996.) From water.

Vibrio grossus (Migula) Ford. (Vibrio No. 1, Kutscher, Ztschr. f. Hyg., 29, 1895, 46; Microspira grossa Migula, Syst. d. Bakt., 2, 1900, 1012; Ford, Tevtb. of Bact., 1927, 343.) From liquid manure.

Vzbrio halobicus desulfuricans Horowitz-Wlassowa and Sonntag. (Arb a. d. Stantl. wissensch. Nahrungsmittel-Institut 1931 (Russian); see Ztschr. f. Unters. d. Lebensm., 62, 1931, 597.) A halophilie vibrio found in salted surdines, anchovies and other marine fish.

Vibrio helcogenes Fischer. (Cent. f. Bakt., 14, 1894, 73; Microspira helcogenes Migula, Syst. d. Bakt., 2, 1900, 078) From descriptions, indistinguishable from Vibrio proteus according to Chester, Man. Determ. Bact., 1901, 330. From foces.

Vibrio hyos Ford. (Vibrio No 3, Kutscher, Ztschr. f. Hyg., \$0, 1805, 46 Spirillum mobile Migula, Syst. d. Bakt., 2, 1900, 1020; Ford, Textb. of Bact., 1927, 342.) Isolated from liquid manure.

Vibrio iners Besson, Ranque and Senez (Compt. rend. Soc. Biol. Paris, 79, 1918, 1007) From the feces of persons having dysentery.

Vibrio intermedius (Migula) Ford. (Group V, No. 9 of cholera like vibrios, Kutscher, Ztschr. f. 11yg., 20, 1805, 481; Microspira intermedia Migula, Syst. d. Bakt., 2, 1900, 907; Ford, Textb. of Bact., 1927, 312.) Possibly identical with Vibrio beroluensis Neisser. From water.

Vibrio ivanoff Pfeiffer. (Ivanofi, Ztschr f. Hyg, 15, 1803, 134; Pfeiffer, in Flugge, Die Mikroörganismen, §, 1806, 592.) Probably a variety of Vibrio comma Winslow et al. according to Chester, Man. Determ. Bact., 1901, 337. From feces of a cholera patient.

Vibrio jejuni Jones, Orcutt and Little. (Jour. Exp. Med., 53, 1931, 853.) From small intestine of calves suffering from diarrhea.

Vibrio kegallensis Hauduroy et al.

(Diet. d. Baet, Path., 1937, 514 ) From nater.

Vibrio klimenko Haudurov et al (Klimenko, in Violle, Le Choléra, Masson Ght., 1919; Haudurov et al., Dict d. Bact. Path., 1937, 514 ) Resembles Vibrio comma. From the intestine

Vibrio leidensis Horst (Inaug Dies Leiden, 1921; abst. in Cent f Bakt I Abt , Ref , 73, 1922, 282 ) From a hver abscess.

\*Vibrio Lingualis Unsemberg (Zungenbelag-Vibrio, Weibel, Cent f Bakt 4 1888, 227, Lisenberg, Bakt Diag , 3 Aulf , 1891, 212; Spirillum linguae Sternberg Man of Bact , 1893, 697, Spirosoma linguale Migula, in Engler and Prantl Die natūri, Pfianzenfam , 1, 1 a, 1995, 31 i From deposit on the tongue

Vibrio lissabonensis Pestana Bettenrourt. (Cent. f. Bakt , 16, 1891, 101 ) According to Chantemesse identical, or nearly so, with Vibrio protous descriptions, industinguishable from I'abrio proteus according to Chester, Man Determ Bact., 1901, 339 From feers

of a cholera patient.

Vibrio malamoria Kalpina (Latvijas Universitates Baksti, Serija I. Vu II. 930, 250.) Decomposes cellulose From wil.

Vibrio. l'ord marinus (Russell) (Spirillum marinum Russell, Zischr I Hyg., 11, 1891, 165, Microspira marina Migula, Syst. d. Bakt . 2, 1909, 1002, Ford, Texth of Bact , 1927, 317 ; From ma water. Closely resembles librio cunculus Gray and Thornton and Vibrae

cardii lilcin.

Vibrio massanal Philler (Pasquale, Gor, med. d. r. esercito, 1831, Pasquile. Baummerten's Jahre sherichte, 7, 1891, 336. Pleifer, in Plagre, Die Miknwigeinstnien. 2.18%, 389, Metrospira massasah Miguls. Syst of Bakt., 2, 1901, 963, Spirithum mariauak Chester, Manual Determ Bart, 1901, 313, Specillum marriedh Helland, Joyr Bart. 5, 1921, 225, Viter warrant Holland, that : From ferre of a tholers patient

Anaerobe From the female general tract Vibrio napi Kalnina (Latvijas Cin versitätes Raksti, Serija I. Au. 11, 1930. 252 ) Decomposes cellulose I'mm soil

Librio n'dianka Hamburos et al (Thironx, in Violle, Le Choléra, Masson édit , 1919, Hauduroy et al , Dict d Bact Path , 1937, 516 ) Isolated from a pitient having a cholera like disease

Vibrio periconia Kalnin's (Latvins Universitätes Raksti, Seriia I. No. 11, 1930, 256 ) Decomposes cellulose Unim

Libria polymorphus Prévot (Spiro eliete B, Repaer, Aim Inst Pist , 26. 1912, 511, Vibrio pseudospirochaeta B. Weinberg, Nativelle and Prévot, Les Microbes Anacrobies, 1936, 852, Privat. Man de Clarsif des Biet Annér, Paris 1940, 83 ) Anaerobe Prom the buccul eas ets

Libria polymorphus var peritriche Prévat (Spirochète C. Repart, Ann Inst. Past , 26, 1912, 518, Vibrio preudo spirochacta C. Weinberg, Nativelle and Prévot, Les Microbes Anatrobies, 1936, 851, Prevet, Man de Classif des Bart Anier, Paris, 1910, St.) Ameride From the buccal cuvity

Libras portuenzas (Migula) Ford (Der normenser Vilitio Jorge, Crut f Bakt . I Abr. 19, 1896, 277, Wierespira pertuen ses Migula Syst d Bokt 2 1900, 1007. Ford Textb of Bart , 1937, 351 / I from

water Pibrio prima Isaliani (Latvijis Cui versitates Bakati berga I No. 11, 1020. 215 ; Decomposes rellulose Promisod

presed is pircel acta 1 1 720 ispinieliete A. Repuer, Ann. Inst. Past., pr. 1912, 574, Valera prevel approach reta A. Weinberg, Namelle and Privat, Les Marches Anima co 1936, 40, Prime, Man de Cheuf des Beet Arair , l'aris, 1910, 53.1 Amende. I not the luces? Citte

Viteo patrides Privat (Vilaber C. Report, Court and he But Pana.

Librio mulieris Prévot (Man Classif des Bact. Anaér , Paris, 1910, 81 )

<sup>\*</sup> bee Averelia lingualis Claimers and Classing erain

1909, 630; Prévot, Man. de Classif. des Bact. Anaér., Paris, 1940, 83.) Anaerobe.

From the buccal cavity.

Vibrio pyogenes (Deerr) Lehmann and Neumann. (Eiterspirillum, Mezinescu, Cent. I. Bakt, I Abt., Orig., 35, 1904, 201; Spirillum pyogenes Doerr, Cent. f. Bakt., I Abt., Orig., 35, 1905, 15; Lehmann and Neumann, Bakt. Diag, 4 Aull., 2, 1907, 493) From pus in a case of pyelitis calculosa. Non-motile.

Vibrio ranicula Kalnins, (Latvijas Ūniversitātes Raksti, Serija I, No. 11, 1930, 248.) Decomposes cellulose. From soil.

Vibrio rigensis Kalniņš. (Latvijas Ūniversitātes Raksti, Serija I, No. 11, 1930,254) Decomposes cellulose. From soil.

Vibrio rubicundus Gottron et al. (Gottron, Weaver and Sherago, Jour. Bact., 45, 1942, 61.) From a trickling filter

Vibrio septicus Kolle. (Kolle and Schumann in Kolle and Wassermann, Handb. d. path. Mikroorg., 2 Aufi., 4, 1912, 101) Identical with Vibrio comma culturally and morphologically. From a cholera-like disease.

Vibrio smithi (Migula) Ford (Smith, Cent f. Bakt, 10, 1891, 177; Microspira smithis Migula, Syst. dt Bakt., 2, 1900, 1906; Ford, Textb of Bact, 1927, 340) Possibly identical with Microspira saprophiles Migula, Microspira weibelii Migula, Microspira cloaca Chester and Vibrio swrati Ford From abseesses of large intestine of swine.

Vibrio spermatozoides Loffler. (Cent. f. Bakt., 7, 1890, 638.) From kohlrabi

infusions.

Vibrio sputigenus (Miller) Prévot. (Spirillum sputigenum Miller, Die Mikroorg, d. Mundhöhle, 2nd ed., 1892; Prévot, Man. de Classif. des Bact. Anaér., Paris, 1940, 85; not Vibrio sputigenus Bergey et al., Manual, 1st ed., 1923, 80.) Anaerobe. From the buccal cavity.

Vibrio sputigenus var. minutissimus Prévot. (Muhlens, Cent. f. Bakt., I Abt., 48, 1909, 523; Prévot, Man. de Classif. des Bact. Anaér., Paris, 1910, 85.) Anacrobe. From the buccal cavity.

Vibrio sputorum Prévot. (Man. de Classif. des Bact. Anaér., Paris, 1910, 85.) Anaerobe. Isolated from a case of bronclutis.

Vibrio stationis Kalniņš. (Latvijas Ūniversitātes Raksti, Serija I, No. 11, 1930, 239.) Decomposes cellulose. From soil.

Vibrio stomatitis Prévot. (Vibrion A, Repaci, Compt. rend. Soc. Biol. Paris, 1909, 630; Prévot, Man. de Classif. des Bact. Annér., Paris, 1940, 82.) Anaerobe. From the buccal cavity.

Vibrio subtilissimus (Migula) Ford Gpirillum No. 1, Kutscher, Ztschr. f. Hyg., 20, 1805, 40; Spirillum tenerrinum Lehmann and Neuman, Bakt. Diag. 4, 1896, 346; Spirillum subtilissimum Migula, Syst. d. Bakt., 2, 1900, 1020; Ford, Tevtb. of Bact., 1927, 341.) Regarded by Kutscher as being probably identical with the organism found by Smith (Cent. f. Bakt., 16, 1804, 324) in swine dung Resembles Vibrio strictus.

Vibrio suis Ford. (Vibrio No. 2, Kutscher, Zischr. f. Hyg., £0, 1805, 46; Spirallum coprophilum Migula, Syst. d. Bakt. £, 1900, 1019; not Microspira coprophila Migula, loc. cil., 986; Ford, Textb. of Bact., 1927, 341.) From liquid manuro.

Vibrio surati (Lumb and Paton) Ford.
(Spirillum surati Lumb and Paton, Arch.
Int. Med., 18, 1013, 259; Treponema
surati Brumpt, Nouveau Traité de
Médecine, Paris, 4, 1922, 541; Forextb of Bact., 1927, 337.) Isolated
from a case of vegetative endocarduis.
Closely resembles Vibrio smithii Ford,
Microspira weibelii Migula, Microspira
suprophiles Migula and Microspira cloace
Chester.

Vibrio synthetica Kalninš. (Latvijas Universitātes Raksti, Serija I, No. 11, 1930, 245.) Decomposes cellulose From soil.

Vibrio tenuis Veillon and Repaci.

(Ann. Inst. Past., 26, 1912, 300) Anacrobe. From the buccal cavity.

Vibrio terrigenus Gunther. (Cent. f. Bakt., 18, 1894, 746; Sprillum Europenum Migula, Syst. d. Bakt., 2, 1900, 1017; Microspira terrigena Chester, Man. Determ. Bact., 1901, 341.) Closely related to Vibrio lonsillarus Stephens and Smith. From soil.

Vibrio tonsillaris Stephens and Smith. (Cent. f Bakt., 19, 1896, 929; Mierospira tonsillaris Migula, Syst. d Bakt, \$,

1900, 1009.) Closely related to Vibrio terrigenus Gunther. From buccal cavity.

Vibrio toulonensis Hauduroy et al. (Vibron, Defressine and Cazeneuve, in Violle, Le Choléra, Masson édit., 1919; Hauduroy et al., Diet. d Bact. Path., 1937, 547.) From mussel beds in the bay of Toulon.

Vibrio xylitico Kalniņš (Latvijas Universitātes Raksti, Serija I, No. 11, 1930, 232.) Decomposes cellulose. From soil

Genus II. Desulforibilo Kluyver and van Niel.\*

(Cent f. Bakt., II Abt., 94, 1936, 389, Sparovibrio Starkey, Arch. f. Mikrobiol., 9, 1938, 300) From M. L. desuljo, an abbreviation of the poorly constructed word desulfofication, used to indicate reduction of sulfur compounds by bacteria; where, vibrio.

Slightly curved rods of variable length, usually occurring singly but sometimes in short chains which have the appearance of spirilla. Swollen pleomorphic forms are common. Actively motile by means of a single polar flagellum. Strict anaerobes which reduce sulfates to hydrogen sulfade found in sta water, marine mud, fresh water, and soil

The type species is Desulforibrio desulfuricans (Beijerinck) Kluyver and van Niel.

Desultovibrio desulluricans (Beijerinck) Kluyver and van Niel (Bacterium hydrosulfureum ponticum Zelinsky, Proc. Russ Phys and Chem. Soc , 25, 1893, 298, Spirillum desulfuricans Beijerinck, Cent. f. Bakt., 11 Abt , 1, 1803, 1: Bacillus desulfuricans Saltet, Cent. f. Bakt., II Abt., 6, 1900, 648; Microspira desulfuricans Migula, Syst d. Bakt . 2, 1900, 1016; Kluyver and van Nicl, Cent. f. Bakt, II Abt, 94, 1936, 369, Vibrio desulfuricans Holland, Jour. Bact., 5, 1920, 225, Sporocibrio desulfuricans Starkey, Koninkl. Nederland Akad. v. Wetenschappen, Proc., 41, 1938, 425; also in Arch f. Microbiol., 9, 1938, 268.) From M L present part desulfurico, sulfur reducing.

Slightly curved rods, 0.5 to 1.0 by 1 to 5 microns, usually occurring singly but sometimes in pairs and short chains which cause them to look like spirilla. Swellen pleomorphic forms are common. Older cells speper black due to precipitated ferrie sulfide. Actively motile, possessing n polar fagellum Grannegative. Stains readily with carbol lurbsin.

Grows best in freshwater media. Fails to develop in sca water upon initial isolation

Produces opalescent turbidity in absence of ovygen in mineral media enriched with sulfate and peptone.

Media containing from salts blackened. Bacteria found associated with precipitated ferrous sulfide.

Peptone-glucose agar colonies (in absence of air): Small, circular, slightly raised, dull, catire, soft in consistency.

Gelatin not liquefied

Peptone, asparagine, glycine, alanine, aspartic acid, ethanol, propanol, butanol,

Prepared by Dr. Claude E. ZoBell, Scripps Institution of Occanography, La Jolla, California, Jan., 1943.

glycerol, glucose, lactate, succinate and malate known to be utilized as hydrogen donors.

Produces up to 500 ml. H2S per liter

Nitrites not produced from nitrates. Reduces sulfate to hydrogen sulfide. Also reduces sulfites, sulfur, thiosulfates and hyposulfites.

Optimum pH 6 to 7.5, limits pH 5 to 9
Optimum temperature 25 to 30° C.
Maximum 35 to 40° C.

Anaerobic.

Habitat: Soil, sewage, water.

2 Desulfovibrio aestuarii (van Dolden) comb noc (Microspira aestuarii van Delden, Cent f. Bakt, II Abt, II, 1904, SI; Yebrio desulfuricans (halophilic strain) Baars, Over Sulfautreductie door Bakterien, Diss Delft, 1930, 164 pp.) From Latin, aestuarium, estuary

Morphologically indistinguishable from Desulforubrio desulfuricans described above, although it has a greater tendency to pleomorphism, and is slightly larger. Motile, possessing a polar flagellum-Grum-necative

Grows preferentially in media prepared with sea water or 3 per cent salt numeral solution enriched with sulfate and peptone. According to Baars (loc cit) the marine species can be acclimatized to tolerate hypotonic salt solutions but Rittenberg (Studies on Marine Sulphate-Reducing Bacteria, Thesis, Univ. of Calif, 1941, 115 pp) was unable to confirm this observation. Likewise Rittenberg was unable to acclimatize D. acstuarii to tolerate temperatures exceeding 55° Cor to produce endosorors.

Produces faint turbidity in absence of oxygen in sea water curriched with sulfate and peptone Organisms most abundant in sediment

Agar colonies Small, circular, slightly raised, darker centers, entire, soft consistency.

Gelatin not liquefied.

Peptone, asparagine, glycine, alanine, glucose, fructose, ethanol, butanol,

glycerol, acetate, lactate and malate known to be utilized in presence of sulfate.

Reduces sulfate to hydrogen sulfide. Also reduces sulfites, sulfur, thiosulfates and hyposulfites.

Produces up to 950 ml. H<sub>2</sub>S per liter. Nitrites not produced from nitrates.

Optimum temperature 25° to 30° C. Maximum 35° to 40° C.

Optimum pH 6 to 8, limits pH 55 to 8.5.

Anacrobic.

Habitat: Sea water, marine mud, brine and oil wells.

3. Desulfovibrlo rubentschickii (Baars) comb. nov. (Vibrio rubentschickii Baars, Over Sulfaatredectidoor Bakterien, Diss. Delft, 1930, 164 pp.) Named for L. Rubentschick.

Slightly curved rods, 0.5 to 10 by 1 to 5 microns, usually occurring singly, sometimes in pairs and sbort chains. Actively motile, possessing a polar flagellum. Gram-negative. Morphologically indistinguishable from Desultoribrio desulturicans.

Reduces sulfate to hydrogen sulfide Also reduces sulfates, sulfur, thiosulfates

and hyposulfites.

Culturally and physiologically like D. desulfuricans except that D. rubenischickii ultines propionic acid, butyric acid, valeric acid, palmitic acid, stearic acid, galactose, sucrose, lactose and maltose.

Anaerobic.

Habitat: Soil and ditch water.

Appendix: The following species has also been regarded as belonging in this genus.

Vibro thermodesulfuricans Eloa (Cent I. Bakt., II Abt., 63, 1924, 58), Vibrio desulfuricans (thermophilic strain) Baars, Over Sulfaatreductie door Baktenen, Diss. Delift, 1930, 164 pp; Sporosobrio desulfuricans Starkey (Konnikl. Nederland. Akad. u Wetenscheppen, Prac., 451, 1938, 425, also see Arch. f.

Microbiol., 9, 1938, 268.) A thermophilic sulfate-reducing anaerobe which grows at 30 to 65°C, and which, according to Starkey, produces endospores. Elion described Vibrio thermodesulfuricans (Cent. f. Bakt., II Abt., 63, 1924, 58) which grows at temperatures no lower than 30 to 40°C, and has an optimum of 55°C. Morphologically it is much like Desulfovibrio desulfuricans and D. aestuarit although the thermophilic form is shorter, more rod-like, less motile and more pleomorphie. According to Baars (loc. cit ), Vibrio thermodesulfuricans Elion can be acclimatized to grow at lower temperatures and it is found abundantly in environments where the temperature has never been as high as 30°C. This observation is confirmed by Starkey (Arch. f. Microbiol . 9, 1938, 203) who found further that the thermophilic form found in nature or developed by acclimatization to higher temperatures produces endospores. However, sporeformation appears to be the exception rather than the rule The pleomorphic, peritrichous, sporogenous, sulfatereducer is more rod-like than the asporogenous cultures and many cells of the sporogenous cultures are Gram-positive whereas asporogenous cultures of Desulfovibrio desulfuricans are Gram-negative. all of which leaves a question whether the sporogenous sulfate-reducer is a Bacillus or a Desulfouibrio. Rittenberg (Studies on Marine Sulfate-reducing Bacteria, Thesis, Univ. Calif., 1941, 115 pp.) was unable to adapt the marine sulfate reducer to grow at low salinities or at high temperatures, nor could it be induced to form spores.

Desulfonibrio halohydrocarbonoclasticus Zohell (U B. Patent No 2,413,278; Science News Letter, Jan. 11, 1947) From oil bearing rocks

# Genus III. Celivibrio Winogradsky."

(Ann. Inst. Pasteur, 45, 1929, 577 ) From M. L. cell, an abbreviation for cellulose. ubrio, vihno.

Long slender rods, slightly curved, with rounded ends, show deeply staining granules which appear to be concerned in reproduction. Monotrichous Most species produce a yellow or brown pigment with cellulose. Oxidize cellulose, forming oxycellulose. Growth on ordinary culture media is feeble Found in soil.

The type angeles is Cellubrio ochraceus Winogradsky.

# Key to the species of genus Cellvibrio.

I. No growth on glucose or starch agar.

A. Ochre-yellow pigment produced on filter paper. 1. Cellmbrio ochraceus.

II. Growth on glucose and starch agar

A. Poor growth on starch agar.

1 Cream-relored pigment which heremes brown with age is produced on filter paper.

2. Cellubrio flavescens.

B. Abundant growth on starch agar.

1. Scanty growth on glucose agar

a Intense yellow pigment produced on filter paper.

3. Celleibrio fulvus

2 Abundant growth on glucose agar. a No pigment produced on filter paper.

4. Cellribrio vulgaria.

<sup>\*</sup> Revised by Prof. Robert S. Breed, New York State Experiment Station, Geneva. New York, Sept , 1937; no change. July, 1943.

1. Cellvibrio ochraceus Winogradsky. (Ann. Inst. Pasteur, 43, 1929, 549, 601.) From Greek, ochra, vellow ochre; M. L. like othre, vellow.

Plump, curved rods with rounded ends, 2.0 to 4.0 microns long, rarely occurring as spirals. Chromatic granule frequently found in center. Motile with a single flagellum. Gram-negative.

Produces diffuse, light ochre-colored, mucilaginous colonies on cellulose silica cel medium.

No action or growth on plain agar. No growth on pentone, glucose, starch or tragacantb gum agar.

Filter paper streaks: Entire paper colored ocbre-vellow in 48 hrs.

Aerobic, facultative.

Optimum temperature 20°C.

Distinctive character Rapid ochrecolored growth.

Habitat Soil. Disintegrates vegetable fibers.

2 Cellvibrio flavescens Wioogradsky. (Ann. Inst. Pasteur, 43, 1929, 608) From Latin, part. adj. of flavesco, to turn yellow or golden.

Plump, curved rods, flexuous, with rounded ends, 0 5 by 2 5 to 5.0 microns. Shows metachromatic granules. Motile with a single flagellum Gram-negative.

Produces diffuse, cream-colored growth becoming brownish; mucilaginous colonies oo cellulose silica gel medium.

Good growth on peptone agar. Colonies 1 mm in 4 days. Grows poorly on glucose, starch and gum agars

Filter paper streaks: Almost as rapid in growth as Cellvibrio ochraceus and colors entire paper in 2 to 3 days.

Aerobic, facultative

Optimum temperature 20°C.

Distinctive characters. Smaller, less curved rods that grow on a greater variety of media than Cellvibrio ochraceus, but do not attack cellulose ns readily.

Source: Isolated from a pile of old damp sawdust.

Habitat: Soil. Disintegrates vegetable fibers.

3. Cellvibrio fulvus Stapp and Bortels. (Culture Y, Dubos, Jour. Bact. 15. 1928, 230; Stapp and Bortels, Cent. f. Bakt., II Abt., 90, 1934, 42.) From Latin, fulrus, reddish vellow,

Slightly curved rods: 03 to 0.4 by 1.5 to 30 microns. Show involution forms. Motile by means of a single polar flagellum. Gram-negative.

Cellulose is decomposed. Grows on filter paper with an intense egg-yellow color which in older cultures may deepen to rust brown.

Glucose agar: Very scanty growth. Sucrose agar: Very slight growth. Maltose agar: Abundant yellow growth.

Lactose agar: Fairly abundant yellow growth. Starch agar: Very abundant, bright

vellow growth which later turns brown. Nutrient broth: No growtb.

Temperature relations: Optimum 25° to 30°C. Minimum 5°C. Maximum 32° to 35°C. No growth at 37°C. Thermal death point 39° to 40°C.

Aerobic.

Source: Isolated from forest soil in Germany and from soil in the United States.

Habitat: Widely distributed in soils.

 Cellvibrio vulgaris Stapp and Bortels. (Culture Co, Dubos, Jour. Baet., 15, 1928, 230; Stapp and Bortels, Cent. f. Bakt., II Abt., 90, 1931, 41.) From Latin, vulgaris, common.

Curved rods: 0.3 by 2 9 to 4.0 microns. Shows involution forms. Motile by means of a single polar flagellum. Gramnegative.

Cellulose is decomposed. Grows on filter paper without the formation of pigment.

Glucose agar: Abundaot growtb. No pigment.

Sucrose agar: Abuodaot slightly yellow growth.

Maltore agar: Abundant yellomish musth.

Lactore agar: Very heavy growth Starch agar: Very abundant pellowish growth.

Nutrient broth: No growth

Temperature relations: Optimum 25° to 20°C. Minimum 5°C. Maximum 32°

to 25°C. No growth at 37°C. Thermal death point 44° to 45°C.

Armine.

Source. Isolated from forest soil in Germany and from soils in the United States

Habitat Widely distributed in soils

## Genus IV Celifalcicula Il inografity "

(Ann. Inst. Pasteur, 43, 1929, 616.). From M. L. cell, an abbreviation for cellulose; Latin dim. Jalcievia. a small sickle.

Short role or spindles, not exceeding 20 micrors in length, with pointed ends, containing metachimistic granules. Old collures show control forms. Monattrictions, Oil fire collubors, forming ony collubors. Growth on ordinary culture media is feelile. So ill heritain.

The type species in Cellfaleienta siri fia Wirewrateky

1. Celifalcicula viridia Wirregradela (Ann. Inst. Pasteur, 45, 192), 616.) from latin confice comm.

Latin, smile, green, Plump, small spiniles, 07 by 20 missons, with manded ends. Moule

with a single fixerllure. Gram negative.
Profuces diffuse green, municipatives
enlanies on cellul se silica cel medium.

Filter juger streaks. Hapid spired or gowth reduced green in 3 dies at 20°C. Hydrocellulies ager. Growth topol, green, rounds pellouish green, rounds

eri mira on atzraking - Mognisti un peptore, glunwe, statch et gum krap

Arrier, taraftature

Optimize temperature 2010 Helatet Kul

2. Califalistuda mucosa Miregra faka eden Ires Paeteren 28, 2009 f.22 e Koles Latin, monosa, koperia

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Die Cares & Care, etche and medical

ligibers a lower on cellulise silies gel medium

Hydrorellul er ager. Almindant grayish errath

No growth on popiete, glumen, statch of gurn first

Aember, facultative

Operation temperature DIC Habital Soil

3 Celifalcitula futta Winegrafily (Arn Irot Posteur 43 1929 622.) From Latin Joseph dark taxon

Plump, corned oper fies 0.5 by 1.2 to 2.5 or or no, with algitty perced on to anche control of matter produce. Motile with a a cyle polar fixedium. Gramregulate.

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## Genus V. Thiospira Vislouch.\*

(Jour de Microbiologie, 1, 1914, 50; Sulfospirillum Kluyver and van Niel, Cent. f. Bakt., II Abt., 24, 1936, 396.) From Greek, theion, sulfur; speira, coil.

Colorless, motile, slightly bent rods, somewhat pointed nt the ends, with granules of sulfur within the cells and a small number of flagella at the ends.

The type species is Thiospira winogradskyi (Omelinnski) Vislouch.

Thiospira winogradskyi (Omelianski) Vislouch. (Thiospirillum winogradskyi Omelianski, Cent. f. Bakt., II Abt., 14, 1905, 769; Thiospirillum granulum Molisch, Cent. f. Bakt., II Abt., 25; Vislouch, Jour. de Microbiologie (Russian), 1, 1914, 50; Sulfospirillum winogradskyi Kluyver and Vislouch, Cent. f. Bakt., II Abt., 24, 1936, 397) Named for Winogradsky, the Russian bacteriologist.

Large, sulfur sp rilla, somewhat pointed at the ends, 2 to 25 microns tbick, to 50 microns long. Numerous granules of sulfur Very motile, with one to two polar flagella

Habitat: Curative mud.

Thiospira bipunctata (Molisch) Visiouch. (Spirillum bipunctatum Molisch, Cent. I. Bakt., II Abt., 55, 1912, 55; Visiouch, Jour. de Microbiologie (Russian), 1, 1914, 50.) From Latin, bi, two; punctum, points.

Small, slightly bent sulfur spirils, markedly pointed at the ends, 6 by 14 micross long, 1.7 to 2.4 micross wide (in the center of the cell). Both ends are filled more or less with large volutin (metachromatic) granules. Several minute granules of sulfur nre present in the clear center and sometimes at the ends. Old cells possess one flagellum at each end; young cells have a flagellum at one end.

Habitat: Sea and salt waters.

## Genus VI. Spirillum Ehrenberg.

(Ebrenberg, Abhandlungen d. Berl. Akad., 1830, 38; Spirosoma Migula, Arb. bakt. Inst. Karlsrube, J. 1894, 237; Dicrospirillum Enderlein, Sitzber. Gesell. naturf. Freunde, Berlin, 1917, 313.) From Greek, speira, a spiro or coil.

Cells form either long screws or portions of a turn. Volutin granules are usually present. Usually motile by means of a tuft of polar flagella (5-20) which may occur at one or hoth ends of the cells. Aerobic, growing well on ordinary culturemedis, except for one saprophyte and the pathogenic species. These have not yet been cultivated. Usually found in fresh and salt water containing organic matter.

The type species is Spirillum undula (Muller) Ehrenherg.

# Key to the species of genus Spirillum.

- I One micron or less in diameter.
  - 1. Volutin granules present.
    - a. Slow to rapid liquefaction of gelatin.
      - h Grayish to hrown growth on potato.
        - 1. Spirillum undula.

Nov. 30, 1936.

Prepared by Prof. D. H. Bergey, Philadelphia, Penn., Octoher, 1922.
† Revised by Prof. D. H. Bergey, Philadelphia, Pennsylvania, April, 1937; further revision by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, June, 1943, based on Monograph by Giesberger, Inaug. Diss., Utrecht,

- bb. Light yellowish-orange growth on potato. 2. Spirillum serpens.
- aa. No liquefaction of gelatin Of small size (0.5 micron in diameter). b. Colonies on agar white becoming brownish black and slightly wrinkled
  - 3. Spirillum itersonii
  - bb. Colonies on agar white and smooth. 4. Spirillum tenue.
- No volutin granules observed. b. Single flagellum
  - bb. Tuft of flagella
- 5. Spirillum virginianum.
- 6. Spirillum minus.
- II. Over one micron in diameter. 1. Grows poorly on peptone agar and potato.

  - 7. Spirillum kulscheri.
  - 2 Not positively known to have been cultivated on artificial media. Very evident volutin granules 8 Spirillum volutans.
  - Cells more or less deformed by fat drops.
    - 9. Spirillum lipoferum.
- 1. Spirillum undula (Müller) Threnerg. (Vibrio undula Müller, Animalila infusoria et marina, 1786; Ehrenberg, fusionstierchen. 1838: ndula minor Kutscher, Gent f. Bakt, Abt., 18, 1805, 614.) From Latin.

ndulatus, wave-like. Stout threads, 09 micron in diameter, ith one-half to three turns. The wave ngths are 6 microns. Width of spiral, 0 microns. Tufts of three to nine

agella at each pole. Volutin granules resent. Gram-negative.

Gelatin colonies: The surface colonies re circular, granular, greenish-yellow, ntire

Gelatin stab: Tluck, white, rugose urface growth Very slow liquefaction. Agar colonies: Gravish-white, smooth Broth: Turbid.

Potato: Gravish-brown growth.

Indole not formed Catalase positive.

Nitrites not produced from nitrates. Acrobic, facultative.

Optimum temperature 25°C.

Cohn (Beitrage z. Biol. d Pflanzen, f. left 2, 1975, 132) reports that he could not distinguish this organism from Vibrio profifer Ehrenberg. Habitat. Putrid and stagnant water.

2. Spirillum serpens (Müller) Winter. (Vibrio serpens Müller, Animalcula in-

fusoria et marina, 1786, 43; Winter, in Rabenhorst's Kryptogamen-Flora, 1, Die Pilze, 1884, 63 ) From Latin, serpens, serpent Long, eurved rods with two to three

wave-like undulations, 08 to 10 micron in diameter; wave length, 8 to 9 microns. Width of spiral 1 5 to 1.8 microns. Volutin granules in cytoplasm. Motile. possessing tufts of flagella at both poles, Gram-negative

Gelatin colonies: Yellowish to brown. ish, granular, entire,

Gelatin stab: Yellowish surface growth. Slow liquefaction

Agar colonies: Heavy cream-colored growth.

Agar slant: Grayish, with yellowish center, granular, entire.

Broth: Turbid. Litmus mill . Unchanged.

Potato: Clear orange-yellow gmwth Indole not formed.

Catalase positive.

Nitrites not produced from nitrates.
Aerobic, facultative.

Optimum temperature 35°C. Habitat: Stagnant water.

3. Spirillum Itersonil Giesberger. (Inaug Diss, Utrecht, 1936, 46 and 57.) Named for van Iterson, the Dutch bacteriologist.

The smallest of the spirilla isolated from water. First observed by van Iterson (Proc. Kon. Akad v. Wetensch. Amsterdam, 5, 1902, 685).

Small spirals, 0.5 mieron in diameter. Wave length, 3 to 3.5 mierons. Spiral width, 1 to 1.5 mierons. Motile with hipolar tufts of flagella. Gram-negative.

Grows readily on peptono agar. White colonies becoming brownish black, and

slightly wrinkled

Gelatin stab No liquefaction

Brownish-oronge growth on potato. Volutin granules may be present.

Catalase is produced.

Acid from glucose, fructose, ethyl alcohol, a propyl alcohol, n-butyl alcohol, and glycerol Utilizes acetic, propionie, n-butyne, tartarie, fumarie, laetie, citrie, and succinic acids.

Grows well in peptone broth Also utilizes ammonia compounds.

Anaerobic growth in the presence of nitrates when organic or ammonia nitrogen is also available.

Optimum temperature · 30°C. Source Isolated from water Habitat · Water.

 Spirillum tenue Ehrenberg. (Infusionstierchen, 1838; see Bonlioff, Arch f Hyg, 26, 1896, 162) From Latin, tenus, thin

Slender spirals Diameter 0.7 micron. Wave lengths 4 5 to 5 0 microns Width of spiral 1 5 to 1 8 microns.

Actively motile in peptone water with tufts of flagella at each pole. Volutin granules present. Gram-negative.

Agar colonies White, smooth.

Peptone agar slant : Heavy growth.

Gelatin stab: No liquefaction.

Catalase positive.

Potato: Light brown growth.

Acid from glucose and fructose Slight acid from several other sugars and glycerols. Utilizes salts of acetic, propionic, n-butyric, tartaric, lactic, citric, malie, and succinic acids.

Ammonia compounds are used as a source of nitrogen.

Optimum temperature, 30°C.

Source: Found in putrefying vegetable matter.

Habitat; Putrefying materials.

 Spirillium virginianum Dimitroff. (Jour. of Bact., 18, 1926, 19.) From M. L. genitive of Virginia.

Spirals consisting of \( \frac{1}{2} \) to 3 complete turns in young cultures, older cultures showing 7 turns. 0.6 to 0.9 by 3 to 11 microns. Motile with a single polar flagellum on one or both ends. Gramnegative.

Gelatin colonies: Entlre, convex, cir-

cular, moist, colorless.

Gelatin stab: Growth along entire stab No liquefaction. (Dimitroff, loc. cit) Active liquefaction. (Glesberger, Inaug Diss., Utrecht, 1936, 65.)

Agar colonies: Dew drop, convey,

entire, moist, colorless.

Agar slant: Dew drop, isolated colonies Broth: Cloudy, no flocculation.

Uschinsky's protein-free medium: Abundant growth.

Litmus milk: No growth.

Loeffler's blood scrum: Convex, isolated dew drop colonies. No lique-faction.

Lead acetate agar: No H2S.

Voges-Proskauer and methyl red negative.

No volutin granules observed (Giesberger, loc. cit., p. 60).

Potato: No growth Indole not formed.

Nitrites not produced from nitrates

No acid or gas from carbohydrates.

(Dimitroff, loc. cit.). Utilizes lactates and citrates (Giesberger, loc. cit.) Aerobic, facultative.

Optimum temperature 35°C.

Source: Isolated from mud on an oyster shell.

Habitat, Probably muddy bottom of brackish water.

6. Spirillum minus Carter, (Carter,

Sei Mem. Med. Officers Army India, 5, 1887, 45; Spirillum minor Carter, ibid.; Spirochaeta laverant Breint and Kinghorn, Mem. Liverpool Sch. Trop Med . 21, 1906, 55; Spirochacta muris Wenyon, Jour Hyg., 6, 1906, 580, Spirochaeta muris var virginiana MacNeal, Proc Soc. Exper. Biol, and Med , 4, 1907, 125; Spirochaeta muris var. galatziana Mczincescu, Compt. rend. Soc Biol Paris, 66, 1909, 58; Treponema muris Moore, Principles of Microbiology, 1912, 414, Spirachaeta morsus muris Futaki, Takaki, Taniguchi and Osumi, Jour Evn Med, 25, 1917, 33; Spirochaeta petit Row, Ind Jour. Med. Res., 5, 1917, 386, Spironema muris Noguchi, Jour. Exp. Med., 27, 1918, 584; Spirochaeta japoniea Dujarrie de la Rivière, Ann de Méd , 5, 1918, 181; Spirochaeta morsusmuris Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 117; Spiroschaudinnia moreusmuris Castellani and Chalmers, abid , Spirochaeta sodoku Troisier, 1929, according to Pettit, Contribution à l'Étude des Spirochétid(s, Vanyes, 11, 1928, 23t, Treponema japonicum Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 505, Treponema moraus muris Brumpt, shid . 506; Treponema minor Brumpt, ibid. 507: Treponema laverany Brumpt, shid . 507; Treponema sodoku Brumpt, sbid. 511; Spirochaeta pettits Row, Jour Wrop Med, and Hyg., 25, 1922, 361, Treponemella murte San Giorgi, Patho logica rivista, 14, 1922, 161; Borrelia maria Bergey et al., Manual, 2nd ed., 1925, 435; Spirillum minus var, morsus muris Ruys, Cent. f. Bakt , I Abt , Ong , 105, 1927, 270; Spirillum minus var.

murts Ruys, bid; Spironema minor Ford, Texth, of Bact, 1927, 002; Spironema lacerani Ford, ibid, 1963, Spironema murts var. virginiana Ford, ibid, 1963, Spirella morsismuris Noguchi, in Jordan and Falk, Newer Knowledge Bact and Immun., 1928, 407; Spirella murts Noguchi, ibid) From Latin, minus, less.

Description taken from Adachi, Jour. Exp Med., 55, 1921, 647 and Giesberger, Inaug Diss., Delft, 1936, 67.

Short thick cells: 0.5 by 3.0 microns, having 2 or 3 windings which are thick, regular and spiral. Actively motile by means of bipolar tufts of flagella. Gramnegative.

Has not been cultivated on artificial media

Aerobic, facultative.

Pathogenic for man, monkeys, rats, mice and guinea pigs

This species is regarded by some as a spirochaete. Because of its habitat and wide distribution it has been described under many different names It is possible that some of these names indicate varieties or oven separate species. See Becson (Jour. Amer. Med. Assoc., 123, 1913, 392) for important interature.

Source Found in the blood of rats and

Habitat The cause of rat-bite fever. Widely distributed.

7 Spirillum kutscherl Migula. (Spirillum undula majus Kutscher, Cent. f Bikt. I Abt., 18, 1895, 614; Migula, Sist. d. Bakt., 2, 1900, 1021) Named for Kutscher, the German inetenologist who first isolated the organism.

Stout threads, 1.5 microns in diameter. Wave lengths 10.5 to 12.5 microns. Width of spiral, 3 to 4.5 microns. May bee their spiral form on continued cultivation. Mottle with fulfs of fagella at the poles. Gramingstive.

Gelatin colonies: Transparent, round, surface colonies. Deep colonies, dark brown. Celatin stab: Slow liquefaction.

Agar colonies grow poorly, granular. Deep colonies yellowish-green to dark brown

Agar slant: Delicate, transparent growth.

Potato: Limited growth.

Volutin present.

Catalase positive.

Utilizes malic and succinic acids.
Crows well on peptone broth. Also

utilizes ammonia compounds.
Optimum temperature, 22° to 27°C.

Source: Isolated from putrid materials and liquid manure,

Habitat: Putrefying liquids.

 Spirillum volutans Ebrenberg. (Prototype, Vibrio spirillum Muller, Animaloula iafusoria, 1786; Ehrenberg, Die Infusionstierehen als Velkemmene Organismen, 1833)
 From M. L. volutin.

Spirals 1.5 microns in diameter. Wave length, 13 to 15 microns, width of spiral, 4 to 5 microns. The largest of the spirilla Slightly attenuated eads. Motile, possessing a tutt of ten to fifteen flagella at each pole. Dark granules of volutin in the cytoplasm. Cram-negative.

Migula (Syst. d. Bakt, 2, 1900, 1025) reports that this species has not been cultivated on artificial media, and that the cultures so described by Kutscher (Ztschr. I Hyg., 20, 1805, 58) are of a different species which Migula names Spirillum giganteum. Vahle (Cent. I Bakt., II Abt., 25, 1910, 237) later describes the cultural characters of an organism which he regards as identical with Kutscher's organism. Giesberger (Inaug. Diss., Delft, 1936, 65) saw what he felt was the true Spirillum solutans but could not cultivate it.

Optimum temperature 35°C Habitat: Stagnant water.

Spirillum Ilpoferum Beijerinck (Azolobacter spirillum Beijerinck, Kon. Akad. Wetensch. Amsterdam, 30, 1923, 431 quoted from Ciesberger, Inaug. Diss., Delft, 1936, 24; Spirillum lipoferum Beijerinck, Cent. f. Bakt., Il Abt., 63, 1925, 353; Chromalium lipoferum Bergey et al., Manual, 3rd ed., 1930, 531.) From Creck, lipos, fat; Latin, fero, to bear.

Curved cells with one-half to one spiral turn, containing minute fat droplets. These may deform the cells, Motile with lophotrichous flagella. Gramnegative.

Calcium malate agar coloaies: Circular, small, transparent, dry. The malate is oxidized to calcium carbonate. Cells contain fat drops.

Peptone agar colonies: More abundant development. Cells lack fat dmps and are typically spirillum in form.

Clucose peptone broth: Cells actively motile with large fat drops.

Fixes atmospheric nitrogea in partially pure cultures, i.e., free from Azolobeita and Clostridium (Beijerinek, loc. cit.). Schröder (Cent. f. Bakt., II Aht., 85, 1932, 17) failed to find fixation of nitrogen when she used cultures derived from s single cell.

Acrobic.

Optimum temperature 22°C.

Beijeriack regards this as a transitional form between Spirillum and Azotobacter. Giesberger (loc. cit., p. 64-65) thinks it a Vibrio.

Habitat: Garden soil.

Appendix: The following additional species have been mentioned in the literature. Many are inadequately described. Some may not belong here.

Prepared by Mr Wm. C. Haynes, New York State Experiment Station, General New York, Jan., 1939; Revised by Capt. Wm C. Haynes, Sn. C., Fort Bliss, Texas July, 1943.

Spirella canis Duboseq and Lebailly (Compt rend. Acad Sci. Paris, 154, 1912, 835.) From the stomach of a dog.

Spirillum amyliferum Van Tieghem (Bull. Soc. botan, de France, 26, 1870, 65) Said to produce spores Ford (Textb. of Bact., 1927, 361) thinks this organism was probably a spirochaete because of its mode of division. Found in frog spawn fungus of sugar factories

Spirillum attenuatum Warming (Om nogle ved Danmarks Kyster levende Bakterier. Kjobenhavn, 1876; Spirosoma attenuatum Migula, Syst. d. Bakt., 2, 1000, 939.) Ford (toc. cit., 363) states that this incompletely described organism would now be regarded either as a spirillum or as a spirochacte From sac.

coast of Denmark.

Spirillum cardiopyrogenes Sardjito (Geneesk, Tijdschr voor Ned Indie, 72, 1932, 1359; 151d., 73, 1933, 822.) From blood of a patient with pericarditis

Spirillum colosius Errora (Rec trav bot. Bruvelle, 8, 1902; Abst in Cent f Bakt., II Abt., 9, 1902, 603) A giant form isolated from brackish sea water Probably the same as Spirillum rolutans Ehrenberg.

Spirillum concentricum Kitasato. (Cent f. Bakt., 5, 1888, 73) Found in putrefying blood.

Spirillum crassum Veillon and Repaci. (Ann. Inst. Past., 26, 1912, 300) De-

scribed as having peritrichous flagella From lung lesions in human tuberculosis Spirillum endoparagogicum Sovokin. (Cent. f. Bakt., f. 1887, 465) Described as producing spores in old cultures. Trom rain water in bark of poplar tree.

Spirillum giganteum Migula. (Spirillum volutans Kutscher, Ztschr f Hyg., 20, 1895, 58; Migula, Syst d. Bakt., 2, 1900, 1025.) From putrefying liquids

Spirillum hachaizae Kowalski. (Cent f. Bakt., 16, 1891, 321; Spirillum hachaizcum Kowalski, ibid., 321; Spirochaeta hachaizae Castellani and Chalmers, Man. Trop. Med., 1st ed., 1910, 316; Treponema hachaizae Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 495.) Found in feces of cholera patients and also of healthy individuals.

Spirillum kolkwitzii Vislouch. (Jour. de Microbiol. (Russian), 1, 1914, 50.)

Spirillum leucomclaenum Perty. (Zur Kenntniss kleinster Lebensformen. Berne, 1852. Also see Koch, Mitt. Kais. Gesundheitsamte, 1, 1881, 48.) From stagnant water.

Spirillum monospora Dobell. (Quart. Jour. Micr. Sci., 52, 1998, 121.) Described as producing spores. From large intestine of frogs and tosds.

Spirillum nigrum Rist. (Tbèse méd., Paris, 1898; see Cent. f. Bakt., I Abt., 30, 1901, 290) Striet anaerobe from pus. Spirillum osfree Noguchi. (Jour. Exp. Med., \$4, 1921, 295.) From oysters.

Spirilium periplancticum Kunstler and Gineste (Compt. rend. Soc Biol Paris, 61, 1906, 135.) From the intestine of the cockroach, Periplaneta americana.

Spirillum pyogenes Mesincescu. (Cent. f. Bakt, I. Abt, Orig, 55, 1904, 201; Spirochaeta pyogenes Blanchard, Semaine Méd, 26, 1906, 1; Treponema pyogenes Brumpt, Nouveau Traité de Médeeine, Paris, 4, 1922, 511) From a case of pyelitis calculoss

Spirilum rappun De Toni and Trevisan. (Spirochaete, Rappin, Contr. à l'Étude d. Bactér. de la Bouche à l'État normal, 1881, 68; De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889,

1003) From the stomach of a dog. Spirillum recti physicies Beauregard (Compt. rend. Acad. Sci. Paris, 125,

1897, 255.) From ambergris.

Sprullum rugula (Müller) Winter. (Vibrio rugula Müller, Anmaleula influsoria, 1786; Cohn, Beitrage z. Biol. d. Pflanz t., Heft 2, 1872, 178; Bonhoff, Arch f. Hyg., 20, 1896, 162; Winter, Die Pilee, in Rubenhorst's Kryptogamen-Flora, 1884.) Prasmowski found spores, but it is not certain his cultures were pure. Bonhoff also observed spores, but

concluded that they were due to contaminating organisms (Ford, Textb. of Bact., 1927, 360). From water.

Spirillum sportferum Migula. (Syst. d. Bakt., 2, 1900, 1928.) Produces spores. The spirals in which the spore formation is beginning are like Spirillum leucomelaenum Perty (Ford, loc. cit., 336). Giesberger (loc. cit., p. 60) places this and other so-called spore-forming spirilla in Sporospirillum Orla-Jensen (Cent. f. Bakt., II Abt., 22, 1909, 340). From a bean infusion.

Spirillum sputigenum Miller, (Die Mikroorganismen der Mundhohle. Leinzig, 1892, Deutsche med. Wehnschr., 52, 1906, 1 and 348.) Hoffman and Prowazek (Cent. f. Bakt , I Abt , Orig , 41, 1906, 741) claim that Spirillum sputigenum has peritrichous flagella. Giesberger (loc. cit , 63) places this in Sclenomonas Prowazek (Cent f. Bakt., I Abt., Orig., 70, 1913, 36). Muhlens (Cent. f Bakt., I Abt , Orig , 48, 1909, 525) reports 1 to 3 flagella, the majority of the organisms having apparently a single thick flagellum (a bunch of flagella) on the concave side (Ford, loc cit, 367). Anaerobic. From the buccal cavity

Spirillum etomachi Lelimann and Neuinann. (Spirillum Form α, β, γ, δ Salomon, Cent f Bakt, I Abt, 19, 1896, 433; Lelimann and Neumann, Bakt Diag, 2 Aufl, 2, 1899, 362) Found in stomach of dog, cat and rat

Paraspirillum vejdorskii Dobeli. (Arch f Protistenk, 24, 1911, 97) Found only once in fresh water containing Oscillatoria. Flagellate flevible spiral cells described as possessing a nucleus. This may be a protozoan.

Spirobacillus gigas Certes. (Bull. Soc Zool. France, 14, 1889, 322; abst. in Ann. de Microgr., 2, 1889-1890, 137.) From

water.

Yibriothrix tonsillaris Tunnicliff and Jackson. (Organism from Actinomyces-like granules, Tunnicliff, Jour. Inf. Dis., 58, 1926, 366; Tunnicliff and Jackson, ibid., 46, 1930, 12) From tonsillar granules. May be identical with Leptoniz asteroide Mendel and as a Gramnegative, anaerobe may belong in Bacteroides according to Rosehury (Bact. Rev., 8, 1944, 202).

l'ibriothrix zeylanica (Castellani) Castellani. (Spirillum zcylanicum Castellani Jour. Ceylon Branch Brit. Med. Assoc., 7, 1910, 5 and Philipp. Jour. Sci., 5, No. 2, Sect. B., Medical Sciences, July, 1910; Vibrio zeylanicus Castellani, 1913, Bacillus zeylanicus Castellani, 1913 and Vibriothrix zeulanica Castellani, 1917, quoted from Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 1069; Spirobacillus zeylanicus Castellani, Spagnuolo and Russo, Bull. Soc. Path. Exot., 11, 1918, 271.) Motile. Gramnegative. From eases of dysenteric enteritis in Ceylon. This is the type species of the genus Vibriothrix Castellani (see Castellani and Chalmers, loc. cit, 1068).

# FAMILY III. AZOTOBACTERIACEAE BERGEY, BREED AND MURRAY.\* (Preprint, Manual, 5th ed., October, 1938, v and 71.)

Cells without endospores. Relatively large rods or even essect, sometimes almost yeast-like in appearance. The type of flagellation in this genus has been definitely established as pertirehous Gram-negative. Otherste aerobes, usually growing in a film on the surface of the culture medium Gapable of fixing atmosphere nitrogen when provided with earbohydrate or other energy source. Grow best on media deficient in nitrogen. Soil and water bacteria.

I nere is

Genus I. Azotobacter Besjerinck.

(Beijerinck, Cent. f. Bakt, II Abt, 7, 1901, 567; Asolomonas Orla-Jensen, Cent. f. Bakt., II Abt., 24, 1909, 444)

The definition is identical with that of the family. From Gr. azous, not living. French, azote, nitrogen, Gr baktron, rod, stick.

The type species is Azotobacter chroococcum Beijerinck

1 Azotobacter chrococcum Beyerinck. (Cent f. Bakt, II Abt., 7, 1901, 567 and 8, 1902, 3; Bazillus azotobacter Löhnis and Hanrawa, Cent f. Bakt., II Abt. 42, 1914, 1; Bazillus chrococcus Buchanan, General Syst. Bact., Baltumore, 1925, 194.) Prom Gr. chroa, color; coccos, grain; M. L. sphere.

According to Löhnis and Smith (Jour. Agr. Res , 23, 1923, 401) Azotobacter beigerinchis Lipman (New Jersey Agr Exp. Sta. Rept., 25, 1904, 247), Azotobacter woodstownii Lipman (ibid ), Azolobacter smyrnii Lipman and Burgess (Cent. f. Bakt., II Abt., 44, 1915, 504) and Azotobacter hilgardii Lipman (Science, 29, 1909, 911) are identical with Azotobacter chroococcum. Greene (Soil Sei. 39, 1935, 327) studied Azotobacter chroscoccum and Azotobacter benerincku by chemical analyses and found the chemical composition of the cells to be practically identical, but different from that of Azotobacter vinclandis and Azotobacter agile. Smith (private communication) feels that Azotobacter beijerinckus is a non-pigmented rough strain of Azelobacter chroocoecum.

Grows in absence of organic nitrogen. Rods: 20 to 30 by 30 to 60 microns, occurring in pairs and packets and occasionally in chains. The cells show three or four refractile granules. The organisms are surrounded by a slimy membrane of variable thickness, susually becoming browness in older cultures, due possibly to the conversion of tyrosine to melanin The coloring matter is insoluble in water, alcohol, ether and chloroform Motale by means of numerous perttrehous flagella (Hofer, Jour Bact., 47, 1944, 415) Gram-negative.

Gelatin colonies: Very small, circular, yellow, granular, later becoming yellowish-brown.

Gelatia stab. Only slight growth in the stab. No liquefaction

Manutol agur stab. Gray, may berome brownish

Nutrient broth No growth even in the presence of glucose, peptone utilized with difficulty

Litmus milk. Becoming clearer in 10 to 14 days.

Potato: Glossy, barely visible, slimy

Revised by Dr. A. W. Hofer, New York State Experiment Station, Geneva, New York, June, 1938; further revision by Dr. A. W. Hofer, July, 1943.

to wrinkled; may become yellowish, hrownish-yellow or chocolate hrown.

The organism fixes atmospheric nitrogen and gives off CO2, utilizing glucose and sucrose. Other generally used carbon compounds are fructose, maltose, mannitol, inulin, dextrin, galactose, arabinose, starch, glycerol, ethyl nlcohol, acetate, hutyrate, citrate, lactate, malate, propionate and succinate.

Nitrate: Improves growth in amounts less than 1 gm. per liter, greater amounts are toxic.

Fixes nitrogen moderately netively. Chemical analysis: Four-day cultures grown upon mannitol agar (Greene. 1935), when dried, are found to contain less than 0.5 per cent of hemicelluloses, less than 20 per cent of crude protein, less than 5 per cent of ash, and more than 30 per cent of lignin-like materials. The nitrogen fraction contains less than 1 per cent of amide nitrogen, less than 1 per cent of humin nitrogen and about 1 per cent of basic nitrogen.

Aerobie

Optimum temperature 25°C, to 28°C. Distinctive characters: Inability to grow in peptone media, even in the presence of glucose, frequent occurrence of a dark brown or black pigment. Source: Isolated from soil

Habitat: Occurs naturally in the majority of neutral or alkaline field soils

Azotobaeter agile Beijerinck (Cent. f. Bakt., II Abt., 7, 1901, 577.) From L. agilis, agile, quick.

In studies on the chemical composition of cells Greene (Soil Sci., 59, 1935, 327) found Azotobacter vinelandii Lipman (New Jersey Agr. Exp. Sta. Rept., 24, 1903, 238) to be very similar to Azotobacter agile Beijerinck. Smith and Löhnis (Jour. Agr. Res., 23, 1923, 401) agree and state furthermore that the two nre identical: they believe also that Azotobacter vitreum Löhnis and Westermann (Cent f. Bakt, II Abt., 22, 1908, 234) is another synonym of Azotobacter agile.

Smith (private communication) states that Azotobacter vitreum is a very weak growing, smooth strain of Azotobacter agile. Kluyver and van Reenen (Arch. Mikrobiol., 4, 1933, 299) feel that a distinction should he made hetween Azolo. bacter agile and Azotobacter vinelandii In regard to the former, Kluyver and van den Bout (Arch. Mikrobiol., 7, 1936, 263) suggest that it be further subdivided into Azotobacter agile and Azotobacter agile var. atypica, the latter referring to nn Azotobacter agile form that fails to produce pigment.

spherical. Actively motile by means of numerous peritrichous flagella (Hofer, loc, cit). Some strains are reported to be non-motile. Gram-nemtive.

Rods: 4 to 6 microns in length, almost

Grows in absence of organic nitrogen. Gelatin: No liquefaction.

Mannitol agar colonies · Circular, gray. ish white, translucent with whitish center. Washed agar colonies: Show slight

bluish-creen fluorescence.

Mannitol agar slant: Grayish, trans-

lucent, fluorescent. Plain agar slant: Yellowish-white, smooth, glistening, translucent with

opaque center. Broth: Turbid, with sediment.

Litmus milk: Becoming clear in 10 to

14 days.

Potato: Yellowish-white, slimy, becoming yellowish-hrown. In the presence of organic acids, a

greenish or reddish pigment is formed The organism fixes atmospheric nitro-

gen actively, and gives off CO:. Aerobic.

Chemical analysis: Four-day cultures grown upon mannitol agar (Greene, 1935), when dried, contain more than 4 per cent of hemicelluloses, more than 45 per cent of crude protein, more than 7 per cent of ash, and less than 4 per cent of ligninlike materials. The nitrogen fraction contains more than 1 per cent amide nitrogen, more than 1 per cent humin

nitrogen, and 2 per cent or more of basic

Optimum temperature 25°C to 23°C Distinctive characters. Lack of a brown pigment; occasional fluorescence; growth in peptone broth containing glucose.

Source: Originally isolated from canal water at Delft.

Habitat: Occurs in water and soil

3. Azotobacter Indicum Starkey and De. (Soil Sci. 47, 337, 1939) From L indicus, of India.

Rods Ellipsoidal, from 0 5 to 1 2 by 1 7 to 2.7 microns when grown on nitrogen free glucos agar. One of the distinctive characteristice is the presence of two large, round, highly refractive bodies in the cells, one usually at each end. Motile by means of numerous peritrielious flagella (Hofer, loc. cit.). Gram-negative.

The organism grows slowly but in time produces large amounts of slime Has high acid tolerance, since it grows from pH 3 to 9.

Suerose or glucose agar plates: Colonies are colorless, round, very much raised, and uniformly turbid, having much the appearance of beavy starch paste. After two weeks, a buff to light brown color develons.

Mannitol agar slant; Grows very poorly.

Peptone agar slant with 0 5 per cent glucose; Limited grayish growth,

Nutrient broth: No growth.
Liquid media generally: Turbidity

with some sediment.

Fixes atmospheric nitrogen readily

with either glucose or sucrose as source of energy.

Aerobic

Optimum temperature: 30°C.

Distinctive characters: Tolerance of acidity, wids limits of pH tolerated, abundant clime production, large globules of fat within cells.

Source: Soils of India.

Habitat: Soil

Appendix I: The relationship of the following species to the species placed in Azotobacter is not yet entirely clear.

# Genus Azotomonas Stapp.

(Cent. f. Bakt., II Abt., 102, 1940, 18; not Azotomonas Orla-Jensen, Cent. f Bakt., II Abt., 24, 1909, 484.)

Rod to coccus shaped acrobic bacteria, motile by means of 1 to 3 polar flagella. No endospores. No fat-like reserve food granules in the cells. Form and and gas from glucose, and other sugars and alcohols. Form indols. Chemo-heterotrophic. Many carbon compounds other than sugars used as sources of energy. Active in the fixation of atmospheric nitrogen. Luye in soil. From Gr. arous, not living, French, arots, nitrogen; Greek, monas, a unit; M. L. monad. The type species is Arotemonas insolita.

Arotomonas Insolita Stapp. (Abstracts of Communications, Thurd Internat. Congr. for Microbiol , Sect. VIII, 1939, 306, abst. in Proc. Soil Sci Soc. of America, 4, 1939, 244; Cent. f. Bakt., II Abt., 102, 1940, 1.) From Latin insolitus, unusual.

Coccoid rods: 0 6 to 1.2 by 0 6 to 1.8

Coccoid 10d3: 0 0 to 1.2 by 0 0 to 12

microns. Motile with one to three polar flagella Gram-negative

· Gelatin: No liquefaction.

Agar slant: Glistening white growth.

Agar colonies: Flat, whitish, edge
entire. Weakly fluorescent.

Broth: Strong turbidity. Sediment. Pellicle

Milk: No change.

Potato: Growth somewhat dry, not slimy, dirty gray, spreading.

Nitrites produced from nitrates.

Fixes nitrogen.

Ammonium salts utilized.

Acid and gas from adonitol, arabinose, dextrin, glucose, galactose, glycerne, inositol, lactose, fructose, maltose, mannitol, mannose, raffinose, rhamnose, salicin, sorbitol, starch, sucrose and xylose. Starch is hydrolyzed.

Hydrogen sulfide produced. Optimum temperature 25° to 30°C. Minimum 7° to 9.5°C. Maximum 48°C.

Good growth at 37°C. Thermal death point 60°C. Limits of pH 3.3 to 9.5.

Limits of pH 3.3 to 9.5, Aerohic.

Source: From a mixture of chopped cotton husks and rice hulls. Hebitat: Soil.

Habitat: Soil

#### FAMILY IV. RIHZOBIACEAE CONN.

(Jour. Bact., \$6, 1938, 321.)

Cells without endospores, rod-shaped, sparsely fagellated (one polaror lateral flagellum, or 2 to 4 peritrichous ones); some species non-motile. Usually Gram-negative, One genus (Chromobacterium) produces a violet pigment. Grow nerobically on ordinary culture media containing glueose. Glueose and sometimes other carbohydrates are utilized, without appreciable and formation. Saprophytes, symbionts and pathogens. The latter are usually plant pathogens forming abnormal growths on roots and stems.

#### Key to genera of family Rhizobiaceae.

 Cells capable of fiving free nitrogen when growing symbiotically on the roots of Leguminosae.

Genus I. Rhizobium, p 223.

II. Either plant pathogens which attack roots or produce hypertrophies on stems, or free-living non-chromogenic soil or water forms Do not fix nitrogen.

Genus II Agrobacterium, p. 227.

III. Usually free-living soil and water forms which produce a violet chromogenesis.

Genus III. Chromobacterium, p 231.

# Genus I Rhizobium Frank.\*

(Phytomyza Schroeter, in Cohn, Kryptogamen-Flora von Schlesien, 5, 1886, 184; Frank, Bert d. deut. bot. Gesellsch, 7, 1889, 389, Rhivobacterium Kirchner, Beitr z. Biol. d. Pflanzen, 7, 1895, 221; Rhizomonao Orla-Jensen, Cent. f. Bakt, II Abt, 22, 1909, 323) From Greek rhiza, root, bios, life

Rods: 0 5-0.0 teroidal forms

in which acidi

negative. Aerobic, heterotrophic, growing best with extracts of yeast, malt or other plant maternals. Nitrates may be reduced to intrates. Nitrates are not utilized Gelatin is not hquefied or is very slightly hquefied after long incubation. Optimizing temperature 25°C. This group is capable of producing nodules on the roots of Leguinizease, and of fixing free introgen during this symbiosis.

The type species is Rhizobium leguminosarum Frank

# Key to the species of genus Rhizobium.

Litmus milk alkalıne.

a. Formation of serum zone in milk

- Moderate growth, slight and reaction on yeast water agar plus mono-, diand trisaccharides.
  - c. Causes formation of root nodules on species of the genera Lathyrus, Pisum, Victa and Lens. Bacteroids irregular with x, y, star-, and club-shaped forms; rods peritrichous when young.

1. Rhizobium leguminosarum.

ce. Causes formation of root nodules on Phaseolus vulgaris, P. multiflorus and P angustifolius. Bacteroids vacuolated rods, few branched forms, young cells peritrichous.

2 Rhizobium phaseoli.

on, Wis , Jan.

- ccc. Causes formation of nodules on species of genus Trifolium. Bacteroids pear-shaped, swollen, vacuolated. Pentoses usually not fermented.
  - 3. Rhizobium trifolii.
- aa. No serum zone formed in milk.
  - b. Scant growth, alkaline reaction on yeast water agar plus most carbohydrates.
    - c. Causes formation of nodules on species of genus Lupinus and on Ornithopus sativus. Bacteroids vacuolated, rods seldom hranched.
    - 4. Rhizobium lupini.
      cc. Causes formation of nodules on Soja max. Bacteroids long slender
      - rods, seldom vacuolated or hranched; young cells monotrichous.

        5. Rhizobium japonicum.\*
- 2. Litmus milk acid.
  - a. Formation of scrum zone in milk.
    - Moderate growth, slight acid reaction on yeast water agar plus mono, diand trisaccharides.
      - c. Causes formation of root nodules on species of the genera Melilotus, Medicago, and Trigonella. Bacteroids cluh-shaped, branched, young cells peritrichous.
        - 6. Rhizobium meliloti.

Naturreiche. 2 Theil, Batanik, III Abt., Kiyptogamen, Sec. 914, 1877, 1941; Schinzia leguminosarum Frank (all species), Bot. Zig., 37, 1879, 377; Phylomyza leguminosarum Schroeter (all ex-

emend. Baldwin and Fred. (Frank, Landwirtschäftliche Jahrhucher, 19, 1890, 583; Zhizobium polymorphum Dangeard, Rhizobium fabae Dangeard, Le Botaniste, Sér 16, 1926, 192-194; Baldwin and Fred, Jour. Bact., 17, 1929, 146.) From Latin, of the legumc family (Leguminosae).

1 Rhizohium leguminosarum Frank

Nore: The following hinomials have been used for species of this genus. The names given were used by their authors to cover one or more of the species here recognized as belonging to the genus Rhizobrum. Where a question mark (?) is used it indicates that the species was too poorly described to be recognizable today. Schinzu cellulicola Frank, 1817 (all species) Leunis, Synopsis der drei

species), Bot. Zig., 46, 1883, 726; Barillus fabae Beljerinek (from broad hean) sad Bacullus ornithop. Beljerinek (from serradella), Bot. Zig., 48, 1890, 837; Cladochytrium tuberculorum Vuillemia species?), Ann. Sci. Agron. Franc. et Etrang., 5, 1, 1888, 193; Bacterum radiciocle Prazmowski (all species), Landw. Vers. Sta., 37, 1890, 204; Ehirobium mutabule Schneider (several species). Rhitobium curvum Schneider (?), Rhito-Rhitobium curvum Schneider (?), Rhito-

No specific name has been proposed for the organism causing the formation of possible inter-relationships of certain plant species of the spoken and cowpea ross-inoculation groups prompted Walker and Brown (Soil Science, 59, 1935, 221-225) to propose a consolidation of the two groups to be recognized as being inoculated by a single species, Rhizobrum faponicum. Results obtained recently by Reid and Baldwin (Proc. Soil Sci. Soc. Amer. for 1936, 1, 1937, 219) show these inter-relationships to include the luping group also.

bium frankit var. majus and var minus Schneider (?), Rhizobium nodosum Schneider (?), Rhizobium dubium Schneider (?), Bul. Torrey Bot. Club, 19, 1892, 213, Rhizobium sphaeroides Schneider (?), Ber, deut. bot Gesell., 12, 1894, 16; Bacillus tuberigenus Gonnermann and Micrococcus tuberigenus Gonnermann, Landw. Jahrb , 25, 1894, 654, 657, are thought by Fred, Baldwin and McCoy (University of Wisconsin, Studies in Science, No. 5, 1932, 140) not to be true nodule organisms and to be too poorly described to be recognizable today: Rhuzobium pasteurianum Mazé (all species), Ann. Inst. Pasteur, 13, 1899, 146: Pseudorhizabium ramosum Hartleb (?) (Chem. Zeit., 24, 1900, 887) (used for noninfective culture claimed by Stutzer (Mitt. Landw. Inst Breslau, 1. Heft 3, 1900, 63) to be genuine root nodule organism), Rhizobium radicicola Hiltner and Stormer (several species) and Rhizobium benjerinches Heltner and Störmer (from lupine, serradella and soy bean), Arb. Biol. Aht. f. Land-u Forstwirthschaft a. K. Gesundheitsamte, 3, 1903, 209; Pseudomonas radicicola Moore (all species), U. S. Dept Agr. Bur. Plant Ind., Bul. 71, 1905, 27, Rhizomonas beijerinckii Orla-Jenson and Rhizomonas radicicola Orla-Jensen (see Hiltner and Störmer), Cent. f. Bakt, II Abt , 22, 1909, 328; Bacillus or Bacterium radicicola Löhnis and Ifansen (peritrichous species), Jour. Agr. Research, 20, 1921, 551, Rhizobium radicicolum Bergey et al , Manual, 1st ed., 1923, 40 (monotrichous species); Rhizobium loti Dangeard (from lotus), Rhizobium simplex Dangeard (from sainfoin), Rhizobium torulosum Dangeard (from Scotch broom), Le Botaniste, Sér. 16, 1926, 195-197. Rods · 0.5 to 0.9 by 1 2 to 30 microns

Motile with peritrichous flagella. Bacteroids commonly irregular with x, y, star- and club-shaped forms. Vacuolate forms predominate. Gram-negative

Growth on mannitol agar is rapid, with tendency to spread. Streak is raised, glistening, semi-translucent, white, slimy and occasionally viscous. Considerable gum is formed.

Slight acid production from glucose, galactose, mannose, lactose and maltose. Aerobic.

Optimum temperature 25°C.

Source: Root nodules on Lathyrus, Pssum (pea), Vicia (vetch) and Lens (lentil).

Habitat: Widely distributed in soils where the above mentioned legumes are grown

2. Rhizobium phaseoli Dangeard. (Le Botamste, Sér. 16, 1926, 197.) From Latin, phaseolus, benn; M. L. Phaseolus, a generic name.

Rods. Motile with peritrichous fagella Bacteroids are usually rod-shaped, often vacuolated with few branched forms Usually smaller than in Rhizoburn legaminosarum and R trifolis Gram-negative.

Growth on mannitol agar is rapid with tendency to spread. Streak inoculation is raised, glistoning, semi-translucent, white, simp Occasionally mucilaginous but this character is not so marked as in Rhizolium trifolii.

Very slight acid formation from glucose, galactose, mannese, sucrose and lactose

Aerobic.

Optimum temperature 25°C

Source Root nodules of Phaseolus culgaris (kidney bean), P angustifolius (bean) and P. multiforus (scarlet runner) (Burrill and Hansen, Ill. Agr. Exp Sta. Bul 202, 1917, 137.)

Habitat Widely distributed in the soils in which beans are grown

3 Rhizobium trifolii Dangeard. (Le Botaniste, Sér. 16, 1926, 191.) From M. L. Trifolium, a generic name.

Rods: Motile with peritrichous flagella. Bacteroids from nodules are pearshaped, swollen and vacuolated. Rarely and y shapes. Gram-negative.

Growth on mannitol agar is rapid. The colonies are white becoming turbid with age. Frequently mucilaginous, Streak cultures transparent at first. Growth mucilaginous later flowing down the agar slant and accumulating as a slimy mass at the bottom. Produces large amounts of gum.

Slight acid production from glucose, calactose, mannose, lactose and maltose, Acrobic.

Optimum temperature 25°G. Source: Root nodules of species of

Trifolium (clover).

Habitat: Widely distributed in the soils where clover grows.

4. Rhizobium lupini (Schroeter) Eckhardt, Baldwin and Fred. (Phytomyza lupini Schroeter, in Colin, Kryptogamen-Flora von Schlesien, 3, I, 1886, 135; Rhizobium minimum Dangeard, Le Botaniste, Sér. 16, 1926, 198; Eckhardt, Baldwin and Fred, Jour. Bact , 21, 1931, 273.) From Latin, Lupinus, lupine.

Rods: Motilo with flagella 1 to 4, usually 2 or 3 Bacteroids are vacuolate rods. seldom if ever branched. Gram-negative. Growth on yeast water, mannitol agar

is scant to moderate with alkaline reaction.

Beef-peptone gelatin: Little growth with extremely slow liquefaction.

On galactose an alkaline reaction serves to differentiate Rhizobium lupini from all fast-growing rhizobia (R. phascoli, R. meliloti, R trifolii, and R leguminosarum). An initial alkaline reaction followed more quickly by an acid reaction on rhamnose and avlose separates R. lupini from slow-growing R. japonicum and the Rhizobium sp. from cow pea.

In general Rhizobium lupini produces slight to moderate acidity on pentose sugars and no change or alkaliac reaction on hexoses, disaccharides and trisac-

charides.

Litmus milk: No serum zone, no reduction, and a slight alkaline reaction.

Meager growth on potato and parsnip slants, and carrot agar.

Acrobic.

Optimum temperature 25°C.

Source: Root nodules on Lupinus (lunine), Serradella and Ornithopus. Habitat: Widely distributed in soils in which these legumes grow.

5. Rhizoblum japonicum (Kirchner) Buelianau. (Rhizobacterium japonicum Kirchner, Beitrage zur Biol, d. Pflanzen, 7. 1895. 213: Pseudomonas japonica Löhnis and Hansen, Bacterium japonicum Löhnis and Hansen, Jour. Agr. Res., 20, 1921, 551; Rhizobium sojae Dangeard, Le Botaniste, Sér. 16, 1920, 200; Buehanan, Proc. Iown Acad. Sci., 55, 1926, 81.) From M. L., of Japan.

Rods: Motile with monotrichous fiagella Bacteroids of nodules are long and slender with only occasional branched and swollen forms. Gram-negative.

Growth on manuitol ngar is slow and scant. The streak is slightly raised, glistening, opaque, white, butyrous, with little gum formation.

Pentose sugars give better growth than

the hexoses.

Little if any neid formed from rarbohydrates. Acid slowly formed from xylose and arabinose.

Aerobic.

Optimum temperature 25°C.

Source: Root nodules on Soja max (soy bean).

Habitat: Widely distributed in soils where soy beans are grown.

6. Rblzoblum meliloti Dangeard. (Le Botaniste, Ser. 16, 1926, 194.) From Greek, melilot, a kind of clover; M. L. Melilotus.

Rods: Motilo with peritrichous fla-Bacteroids club-shaped and gella.

branched. Gram-negative.

Growth on mannitol agar is fairly rapid. The streak is raised, glistening, opaque, pearly white, butyrous. Considerable gum is formed.

Acid from glucose, galactose, mannose and sucrose.

Aerobic.

Optimum temperature 25°C.

Source: Root nodules of Melilotus (sweet clover), Medicago, and Trigonella

Habitat: Widely distributed in soils in which these legumes grow.

Note: See Monograph on Root Nodule Bacteria and Leguminous Plants by E. B. Fred, I. L. Baldwin and Elizabeth McCoy, University of Wisconsin Studies in Science, Madison, No. 5, 1932, vx + 313 pp. for a more complete discussion of this group with an extensive bibliography.

#### Genus II. Agrobacterlum Conn. \*

(Jour. Bact., 44, 1942, 359 ) From Greek, ogrus, a field; M.L., bacterium, a small

Small, short rods which are typically motile with 1 to 4 peritrichous flagella (if only one flagellum, lateral attachment is as common as polar). Ordinarily Gramnegative. On ordinary culture media, they do not produce visible gas nor sufficient acid to be detectable by litmus. In synthetic media, enough CO2 may be produced to show acid with brom thymol blue, or sometimes with brom cresol purple is either very slowly liquefied or not at all Free nitrogen cannot be fixed, but other morganic forms of nitrogen (nitrates or ammonium salts) can ordinarily be utilized. Optimum temperature, 25° to 30°C Habitat Soil, or plant roots in the soil; or the stems of plants where they produce hypertrophies.

The type species is Agrobacterium tumefaciens (Smith and Townsend) Conn.

## Key to the species of genus Agrobacterlum.

- I. Plant pathogens. Produce browning of manuatol-calcium-glycerophosphate agar. Nitrate reduction weak or none A. Nitrite produced from nitrate to a slight extent. Galls produced on plant roots.
  - 1. Agrobacterium tumefaciens.
  - B. Nitrite not produced from nitrate.
    - 1. Pathogenic to apples
- 2. Agrobacterium rhizogenes.
- 2. Pathogenic to raspberries and blackberries. 3. Agrobacterium rubi.
- II. Not pathogenic to plants. Produces browning in mannitol-calcium-glycerophos phate agar. Nitrate reduction vigorous, with disappearance of the nitrate
  - 4 Agrobacterium radiobacter. 1923, 189; Conn. Jour. Bact., 44, 1942, 359 ) From Latin tumefaciens, swell-

 Agrobacterium tumefaciens (Smith and Townsend) Conn. (Bacterium tumefactens Erw. Smith and Townsend, Science, N. S. 25, 1907, 672, Pseudomonas tumefaciens Stevens, The Fungi which Cause Plant Disease, 1913, 35, Bacillus tumefaciens Holland, Jour. Bact., 5, 1920, 220; not Bacillus tumefaciens Wilson, Laucet, 1, 1919, 675; Phytomonas tumefaciens Bergey et al . Manual, 1st ed ,

ing up, producing a tumor. Probable synonyms: Bacillus ampelopsorae Trevisan, in Saccardo, Sylloge Fungorum, 8, 1859, 983; Bacillus ampelapsarae Trevisan emend, Cavara, Staz. Sperim. Agara, Ital. Modena, 30, 1897, 483; see Elliott, Bact. Plant Pathogens, 1930, 235.

Prepared by Prof. H. J. Conn, New York State Experiment Station, Geneva, New York, September, 1943.

Among the synonyms listed in previous reditions of the Maoual has been Polymonas tumefaciens Lieske, Cent. I. Bakt., I Abt., Orig., 108, 1928, 118. This is only a partial synonym, however, as its author described it as the cause of animal and human caneer, of which he regarded erown-gall of plants as merely a phase; for the origin of this theory, see Smith and Towosend, Sci., N.S. 25, 1907, 671, and Smith, Jour. Cancer Res., 7, 1922, 1-195.

Description taken from the following: Riker, Banfield, Wright, Keitt and Sagen, Jour. Agr. Res., 41, 1930, 507; Sagen, Riker and Baldwin, Jour.Baet., 28, 1934, 571, Hendrickson, Baldwin and Riker, Jour. Baet., 28, 1934, 597.

Rods: 0.7 to 0.8 by 2 5 to 3.0 mierons, occurring singly or in pairs. Capsules. Motile with 1 to 4 flagella. Grammerative

Agar colonies: Small, white, circular, smooth, glistening, translucent, entire. Broth Slightly turbid, with thin pellicle.

Litmus milk: Slow coagulation. Litmus reduced Neutral to alkaline. Nitrites produced from nitrates to a

very slight extent.

Indole: Slight emount.
Slight acid from glucose, fructose,

ambioose, galactose, mannitol and salicin.
Starch not hydrolyzed.

Optimum temperature 25° to 28°C. Facultative anacrobe.

Distinctive characters: Causes a gall formation parenchymatous in character which because of its soft nature is subject to injury and decay.

Agrobacterium tumefaciers strongly absorbs congo red and aniline blue in contrast to little or no absorption by A. thicogenes. A. tumefaciens makes abundant growth on sodium selenite agar and calcium glycerophosphate medium with mannitol in contrast to no growth or a very slight trace by A. thicogenes (Hendrickson et al., Jour. Bact., 28, 1934, 597).

Source: Isolated from galls on plants. Habitat: Causes galls on Paris daisy and cross-inoculable on over 40 families

Agrobacterium rhizogenes (Riker et al.) Conn. (Bacterium rhizogenes Riker, Banfield, Wright, Keitt and Sagen, Jour. Agr. Res., 41, 1930, 536; Phytomonas rhizogenes Riker et al., ibid. 536; Pesudomonas rhizogenes Riker et al., ibid. 536; Conn. Jour. Bact., 44, 1942, 359.) From Greek, rhiza, root; genes, producing.

Rods: 0.4 by 1.4 microns, occurring singly. Motile with one to 4 flagella Encapsulated. Not acid-fast. Gramnecative.

Gelatin: No liquefaction.

Agar colonies: Circular, smooth, convex, finely granular; optical characters, translucent through gray to almost white.

Agar slant: Moderate, filiform, trans-

lucent, raised, smooth, slimy.

Broth: Turbid, with heavy pellicle.

Litmus milk: Acid, slow reduction.

Litmus milk: Acid, slow reduction.
Indole not formed.
Nitrites not mediand from pitrates.

Nitrites not produced from nitrates. Acid but not gas from nrabinose, XV-lose, rhamnose, glucose, galactose, manose, maltose, lactose, salicin and error britol. No noid or gas from fructose, sucrose, raffinose, melezitose, starch, dextrin, inulin, nesculin, dulcitol or mannitol.

Starch not hydrolyzed.

Optimum temperature 20° to 25°C. Aerobic.

Aerobie. Distinctive characters: Agrobacterium rhizogenes differs from Agrobacterium tumefaciens by stimulating root formation instead of soft parenchymatous crown galls A rhizogenes lacks ability of A. tumefaciens to utilize simple nitrogenous compounds as KNO<sub>2</sub>. A rhizogenes absorbs congo red and brom thymol blue slightly and aniline blue not at all Will not grow on sodium selenite agar (see A. tumefaciens for response to same materials). Does not infect tomato.

Sources: Description made from ten cultures isolated from hairy-root of apple and other plants.

Habitat: Pathogenic on apple, etc

Agrobactertum rubi (Hildebrand)
 Starr and Weiss. (Phylomonas rubi
 Hildebrand, Jour. Agr. Res., 61, 1940,
 604; Bacterium rubi Hildebrand, ibid.,
 604; Basterium rubi Hildebrand, ibid.,
 604; Bashfeld, Phytopath, 20, 1930, 123;
 Punckard, Jour. Agr. Res., 60, 1935, 933.
 Starr and Weiss, Phytopath, 35, 1943,
 316.) From Latin, rubus, blackberry
 bush; M. L., Rubus, a genene name.

Rods: 0.6 by 1.7 microns Singly, in pairs or short chains. Motile with 1 to 4 flagella. Gram-negative.

Gelatin: No liquefaction

Potato-mannitol-agar slants Growth slow, moderate, filiform, white to creamywhite, with butyrous consistency later hecoming leathery.

Broth: Turbid in 36 to 48 hours Milk: A slight serum-zone, pink color,

acid and curd formed.

Nitrites not produced from nitrates Ferrie ammonium citrate, urie acid, oxanide, succinimide, l-asparagine, ltyrosine, l-cystine, d-glutamie acid and yeast extract can be used as a source of nitrogen (Pinckard, loc. cit.).

Hydrogen sulfide not formed

Indole not formed.

Acid from glueose, d-galactore, d-mannose, d-fruetose, d-vylose, d arabusose, sucrose, and maltose None from lactose (Pinchard, loc. cit).

Starch not hydrolyzed

Optimum temperature 28°C Minimum 8°C, and maximum 36°C (Pinckard, loc. cit.).

Distinctive characters Differs from Agrobacterium tunefacers in that it does not utilite intrates, and grows much more slowly on ordinary media. Infects only members of the genus Rubus Starr and Weiss (Phytopath, 55, 1913, 317) state that this species unlike Agrobac-

tersum tumefaciens and Agrobactersum

rhizogenes does not utilize asparagin as a sole source of carbon and nitrogen

Source: Isolated by Banfield (loc. cit.) and by Hildebrand (loc. cit.) from raspberry canes, Rubus spp.

Habitat: Pathogenic on black and purple cane raspberries, and blackberries, and to n lesser extent on red raspberries.

4. Agrobacterium radiobacter (Bei-jerinek and van Delden) Conn. (Bacillus radiobacter Beijerinek and van Delden, Cent. f. Bakt., II Abt., 9, 1902, 3; Bacterium radiobacter Löhnis, Cent. f. Bakt., II Abt., 14, 1905, 589; Rhizobium radiobacter Pinn, Klassifikation der Schiromyceten, Leipzig, 1933,53; Achromobacter radiobacter Bergey et al., Manual, 4th ed., 1934, 250; Atcaligenes radiobacter Conn., in Manual, 5th ed., 1939, 97; Conn., Jour. Bact., 44, 1912,359.) From Latin, radius, the spoke of a wheel; Latin, bactrum, a rad.

Small rods, 0 15 to 0 75 by 0 3 to 2.3 microns, occurring singly, in pairs and under certain conditions, in star-shaped clusters. Motife with one to four flagella. Prevailingly Gram-negative, but an occasional culture is variable.

Nutrient gelatin stab: No liquefaction Agar slant: Flat, whitlsh slimy layer. Mannitol-calcium-glycerophosphate-

agar strenk plates: Abundant, raised, shing growth surrounded by a brown halo with an outer zone of white precipitate (Riker et al., Jour Agr. Res., 41, 1930, 524)

Broth Turbid; with heavy ring or pellicle if yeal infusion is present.

Litmus milk: Serum zone with pellicle in one week; usually turns a chocolate brown in 2 weeks; same in plain milk, but with less browning.

Potato Raised slimy mass becoming brownish; potato may be browned.

Nitrates disappear (assimilated or reduced)

Starch not hydrolyzed.

No organic acid or visible gas from sugars; nearly all sugars, glycerol and mannitol are utilized with the production of CO<sub>2</sub>.

Optimum temperature 28°C. Minimum near 1°C. Maximum 45°C.

Aerobie.

Media containing KNO<sub>4</sub>, K<sub>2</sub>JiPO<sub>4</sub>, and glycerol, ethyl or propyl alcohol become alkaline to phenol red. (Sigen, Riker and Baldwin, Jour Bact, 28, 1931, 571.)

Growth occurs in special alkaline media of pH 11.0 to 12.0 (Hofer, Jour Amer. Soc Agron., 27, 1935, 229)

Hydrogen sulfide produced if grown in ZoBell and Feltham's medium (Jour. Bact. 28, 1931, 169)

Distinctive characters: Browning of mannifol-calcium-glycerophosphate agar. Inability to cause plant disease or to produce nodules ou roots of legumes. Complete utilization (disappenrance of nitrate) in the perfone-salt medium of Riker et al. (Jour. Agr. Res., 41, 1930, 520) and failure to absorb cougo red (bird, 528).

The species bears at least superficial resemblances to certain Rhizobium spr., but may be distinguished from them by the first two chameters listed above, and the following in addition. Growth at a reaction of pli 11-12. Heavy ring or pellicle formation on veal infusion broth. His production in the mainitof-tryptone medium of ZoBell and Feltham (for cit). Production of milky white precipitate on nitrate-glycerol-soil-extract agar.

Source: Isolated from soil

Habitat Soil, around the roots of plants, especially legumes

Nors. Palacios and Bari (Proc. Indian Acad. Sci. 3, 1936, 362, Abs in Cent. f. Bakt, II Abt., 95, 1937, 423) have described Bacillus concomitans as a symbiont from legume nodules that has no power to fix nitrogen although it is very much like legume nodule bacteria (Rhizobium spp.). This organism resembles Agrobacterium radiobacter.

Appendix: The following species probably belong in Agrobacterium, but are not sufficiently well described to make their relationship certain.

 Agrobacterium gypsophilae (Brown) Starr nnti Weiss. (Bacterium gypsophilae Brown, Jour. Agr. Res., 48, 1931, 1109, Pseudomanas gypsophilae Stapp, Bat. Rev., 1, 1935, 107; Phylomonas gyptophilae Stapp, ibid., 407; Starr and Weiss, Phytopatin., 53, 1913, 316.) From M. L., Gypsophila, a generic name.

Rods: 0.2 to 0.8 by 0.4 to 1.4 microns. Motile with 1 to 4 flagella. Capsules.

Gram-negative,
Gelatin: Liquefaction slow, beginning
after 1 month.

Beef-infusion agar colonies: Circular, Naples yellow, smooth or rough, butyrous Broth: Turbid in 21 hours.

Milk: Congulation and peptonization. Nitrites are produced from nitrates

Indole not produced.

Hydrogen sulfide: A trace may be produced.

Acid but not gus from glucose, sucrose, unitese, mannitol and glycerol. No acid from lactose.

Starch not hydrolyzed.

Aerobic, facultative.

Distinctive characters Differs from Kanthomonas belicola in starch hydrolysis, II S production, and will not cross-inoculate with this species.

Source: Isolated from several galls on Gunsonhila.

Habitat: Produces galls in Gygsophila paniculata and related plants.

 Bacterium pseudotsugae Hansenand Smith (Hansen and R. E. Smith, Higardia, 10, 1937, 576; Phylomonas pseudotsugae Burkholder, in Manual, 5th ed., 1939, 209.) From M. L., Pseudotsuga, a generic name.

Rods 0.5 to 1.5 by 1 9 to 3.9 microns Probably motile; type of flagellation doubtful. Gram-negative

Gelatin: Liquefied

Nutrient agar slant: Growth scanty, flat, glistening, smooth, translucent, whitish.

Broth: Growth slight No sediment Milk . No acid.

Nitrites produced from nitrates. Il vdrogen sulfide production slight. Acid but not gas from glucose, fruetose, galactose and maltose. No acid or gas from lactose, sucrose or glycerol.

Starch not hydrolyzed.

Facultative acrobe.

Source. Isolated from galls on Douglas fir in California.

Habitat · Pathogenie on Douglas fir. Pseudotsuga taxifolia.

#### Genus III Chromobacterium Bergonzini.\*

(Ann. Societa d. Naturalisti in Modena, Ser. 2, 14, 188t, 153.) Greck, chroma, color; M. L., bacterium, a small rod

Rods, 04 to 08 by 10 to 50 mierons Motile with 1 to 4 or more flagella. Gramnegative. A violet pigment is formed which is soluble in alrohol, but not in water or chloroform. Grow on ordinary culture media, usually forming acid from glucose, sometimes from maltose, not from lactose Gelatin is liquefied. Indole is not produced. Nitrate usually reduced to nitrate Optimum temperature 20-25°C but some grow well at 37°C Usually saprophytic soil and water bacteria.

The type species is Chromobacterium violaceum (Schroeter) Bergonzini.

#### Key to the species of genus Chromobacterlum,

I Motile rods. Single flagellum.

A. Acid from glucose and maltose No acid from sucrose. Nitrites produced from nitrates. No growth at 37°C

t Chromobacicrium violaceum

II. Motile rods. Flagella generally perstrichous

A. Acid from glucose. Nitrites generally not produced from nitrates Good growth at 37°C

B. Generally no acid from glucose Nitrites produced from nitrates growth at 37°C

2 Chromobactersum santhinum.

Chromobacterlum violaceum (Schroeter) Bergonzini. (Bacteridium tiolaceum Schroeter, Beitrage z Biol d Pflanzen, 1, Heft 2, t872, 126, Micrococcus violaceus Cohn, Beitrage z Biol d. Pflanzen, 1, Heft 2, t872, t57, Cromobacterium violaceum (sic) Bergonzini, Ann. Societa d Naturalisti in Modena, Ser. 2, 14, t881, 153, Bacillus tiolaceus Schroeter, Kryptogamen-Plora von Sehlesien, 3, 1886, 157, Streptococcus violaccus Trevisan, I generi e le specie delle 3 Chromobacterium amethystinum.

Batteriacce, t889, 31, Pseudomonas violacea Migula, Arb a. d Bakt. Inst. Karlsruhe, 1, 1894, 237; Bacterium violaceum Lehmann and Neumann, Bakt. Diag , 1 Aufl , 2, 1896, 58; see 2 Aufl., 2, 1899, 262 ) From Latin, suclaceus. violet-colored

Note: Bacterium ianthinum Zopf (Die Spattpilze, 1885, 68) has been regarded as identical with the above organism by Schroeter (Kryptogamen-Flora von Schlesien, J. t. 1886, 157), and by Leh-

<sup>\*</sup> Adapted by Prof. Robert S. Breed, New York State Experiment Station, Geneva. New York from Cruess-Callaghan and Gorman, Scientific Proc. Royal Dublin Society. 21, 1935, 213 in Jan 1935, further revision, July, t915 by Robert S. Breed with the assistance of Capt. W C Tobie, Sn. C., Old Greenwich, Conn.

mann and Neumann (Bakt. Diag., 1 Aufl., 2, 1856, 266; also 7 Aufl., 2, 1927, 463). Lehmann and Neumann (loc. cit.) also consider Bacillus violaceus laurenticus Lustig (Diagnostik der Bakterien des Wassers, 1893, 103) as being identical with Bacterium violaceum.

Slender rods: 0.8 to 1.0 by 2.0 to 5.0 microns, occurring singly and in chains. Motile, with a single flagellum. Gramnegative.

Gelatin colonies: Circular, gray, entire margin, assuming a violet color in the center.

Gelatin stab: Infundibuliform liquefaction with violet sediment in fluid. Agar colonies: Whitish, flat, glistening.

moist, becoming violet.

Agar slant: Deep, violet, moist, shiny

spreading growth.

Broth: Slightly turbid, with violet

ring and ropy sediment
Litmus milk: Violet pellicle. Diges-

tion. Alkaline.

Potato: Limited, dark violet growth. Löffler's blood serum: Slowly liquefied.

Indola not formed. Nitrites produced from nitrates.

Acid from glucose and usually from maltose No acid from lactosa or sucrose.

Aerobic, facultative.
Optimum, temperature 25° to 30°C.
No growth at 37°C Slight growth at

2° to 4°C.
Source Originally grown on slices of cooked potato exposed to air contamination, and incubated at room temperature.

Habitat: Water.

2. Chromobacterium ianthinum (Zopf) Holland. (Bacterium ianthinum Zopf, Die Spaltpilze, 2 Auft., 1884, 62; Bacillus janthinus Flugge, Die Mikroorganismen, 1886, 201; Bacterdium uanthinum Schroeter, Kryptogamen Flora von Sehlesien, 5, 1, 1886, 157; Pseudomonas tanthina Migula, Syst. d. Bakt. 2, 1900, 941, Pseudomonas janthina Chester, Man. Determ. Bact., 1901, 317; Holland, Jour. Bact., 6, 1920, 222.) From Greek, ianthinus, violet-blue.

Rods: 0.5 to 0.8 by 1.5 to 5.0 microns, occurring singly. Motilo with peritrichous flagella. Cram-negative.

Gelatin colonies: Circular, yellow, becoming violet.

Gelatin stab: White to violet surface growth. Infundibuliform liquefaction. Agar colonics: Creamy center, violet

margin.
Agar slant: Yellowish, moist, glisten-

ing, becoming deep violet.

Broth: Turbid, with light violet pel-

Broth: Turbid, with light violet pellicle.

Litmus milk: Slow coagulation with

violet cream layer. Litmus decolorized from below.

Potato: Violet to violet-black, spreading growth.

Indole not formed.

Nitrites generally not produced from nitrotes.

Acid from glucose. No acid from maltose, lactose and sucrose.

Aerobic, facultativa.

Optimum temperature 30°C. Grows well at 37°C. No growth at 2 to 4°C.

Source: Originally grown on pieces of pig's bladder floated on badly coatsminated water.

Habitat: Water and soil. This may be the species that causes a fatal septicemia in animals and man. See Chromobacterium violaceum manilae.

amethysticum 3. Chromobacterlum (Chester) Holland. (Bacillus membranaceus amethystinus Eisenberg, Bakt. Diag., 1891, 421; Bacterium amethystinus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 117; Bacterium membranaceus amethystinus Chester, ibid., 135; Bacillus amethystinus Holland, Jour. Bact., 5, 1920, 217; not Bacillus amethystinus Chester, loc. cit., 262; Holland, loc. cit., 222; Bacterium membranaceum amethystinum Lehmann and Neumann, Bakt. Ding , 7 Aufl., 2, 1927, 463; Bacterium violaceum amethystinum Cruess-Callaghan and Gorman, Sci. Proc. Royal Dublin Society, 21, 1935, 219.) From Greek, bluish-violet, amethyst.

Rods: 0.2 to 0.8 by 1.0 to 1.1 microns, occurring singly. Motile with a single or occasionally with peritriclous flagells. Gram-negative.

Gelatin colonies Thun, bluish, becoming violet, crumpled

Gelatin ataly: Heavy, violet black pelliele. Liquefied.

Agar colonies: Deep violet, surface ruzose.

Agar slant: Thick, most, yellowishwhite, becoming violet with metallic

luster,
Broth: Pellicle with violet rediment,
fluid becoming violet

Litmus milk; Violet pelliele Digestion turning alkaline

Potato: Deep violet, rugose spreading growth.

Indole not farmed

Nitrites produced from nitrates Usually no acid from glucose, maltose

and sucrose. No acid from lactore
Aerobic, facultative.

Optimum temperature 30°C No growth at 37°C. Good growth in 7 days at 2 to 4°C.

Original source, Yound once by Jolles in spring water from Spulato Habitat; Water,

Appendix: The following organisms have been assigned to this genus or are believed to belong here Additional comparative studies are bally needed Bacillus evance-fuscus Besierunck.

Bacillus eyanco-fuscus Besjertnek. (Beijerinek, Bot Ztung, 49, 1891, 791, Bacterum eyanofuscus Chester, Ana Rept Del. Col. Agr Exp Sta. 9, 1897, 116 and 132) From black glue, blue Edam cheese, water and soil.

Bacillus lacmus Schroeter. (Schroeter in Cohn, Kryptogamen-Flora von Schlesien, 3, 1, 1859, 158) In greenhouse on fresh paint

Bacillus Itlacinus Mace (Tranté Pratique Bact., 6º 6d., 2, 1913, 416.) From nater.

Bacillus membranaceus amethystinus mobilis Germano. (Germano, Cent I Bakt., 18, 1892, 516; Bacillus amethystinus mobilis Kruse, in Plügge, Die Mbkroorganismen, 3 Aufi. 2, 1806, 313; Bacterium amellystinus mobilis Chester, Ann. Hept Del Col Agr Exp Sta. 9, 1897, 117; Bacterium merbannecus mobilis Chester, shul. 133.) Pseudo monas amethystina Migula, Syst d Ikkl. 2, 1800, 911; Bactellus amethystinus Chester, Man. Delerin Bact., 1901, 262.) From dust.

Bacillus paroninus Forster, (Porster, in van der Sleen, Sur l'examen bietériologique qualitatif de l'eau. Arch Teyler, Ser 2. Tome 4, 3 partie, 1891, No. 59, Haarlem, Heritiere Loosjes, Also see These. Nancy, 1931, 16.) Godfrin, Causes blue discoloration of Edam cheese. Bacillus polychromogenes Chamot and (Bacille polychrome, Thiry, Compit rend See Biol , Paris, 49, 1890, 85, Chamet and Thiry, Bot Gaz., 30, 1900, 378 ) From well water at Nanev Probably a Pseudomonus (Tobic, pereou d communication)

Bacillus riolaccus Frankland and Frankland (Trankland) and Frankland, Zischr.f. 11yg. 6, 1883, 391, Pseudomonas pseudonathian Migula, Syst. d. Bakt., 2, 1900, 912.) Isolated from tap water. Raid to produce spores.

Bacillia violaceus laurentius Jordan Jordan, Mass. State Bd Health Rept., 1990, 823, Racterium riolaceus laurentius Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 117, Paeudomonas laurentia Migula, Syst. d. Bakt., 2, 1900, 941; Bacillia violaceus Chester, Man Deterna Baet., 1901, 202, Chromobacterium isolaceum laurentium Ford, Texth. Bact., 1927, 470). Isolated from senage effluer.

Bacillus violaceus lutchensis Krusc. (Krusc, in Flügge, Dio Mikronganismen, 3 Aufl., £, 1896, 311, Bacillus lutchensis Chester, Man. Determ. Bact., 1901, 306; Chromobacterium violaceum lutchiense Ford, Texth. Bact., 1927, 470.) From water.

Bacillus evoluceus sartory: Waeldele. (Thèse, Pharm Strasbourg, 1938, 55.) From dental pus. Said to form spores.

Bacterium cristallino violaceum Cholkevitch. (Cholkevitch, 1922, quoted from Godfrin, Contribution a l'étude des bactéries bleues et violettes. Thése, Nancy, 1931, 93) From peat.

Chromobacterium bampton ii Bergey et al. (Baetlus membranaceus amethystanus 11, Bampton, Cent. f. Bakt., I Abt., Orig., 71, 1913, 137, Bergey et al., Manual, 1st ed., 1923, 119; Chromobacterium membranaceum amethystinum II Ford, Textb. Baet., 1927, 473) From water.

Chromobacterium cocruleum (Voges) Bergey et al. (Bacillus cocruleus Voges, Cent. f Bakt., 14, 1893, 303; Bacterium cocruleus Chester, Ann. Rept Del Col Agr. Exp Sta, 9, 1897, 117; Pecudomonas cocrulea Migula, Syst. d. Bakt., 2, 1900, 945; Bergey et al., Manual, 1st ed., 1923, 120.) From water.

Chromobacterium cohaerens Grimes. (Sci. Proc. Royal Dublin Society, 19, 1939, 381) From well water.

Chromobacterium hibernicum Grimes. (Sci. Proc Royal Dublin Society, 19, 1930, 381.) From well water.

Chromobaeterium lividum (Voges) Ilol-(Plagge and Proskauer, Zeitsch. land f Hyg., 2, 1887, 463; Bacıllus lividus Voges, Cent f. Bakt , 14, 1893, 303; relationship to Bacıllus lividus Zimmermann uncertain. Die Bakt. unserer Trink- und Nutzwässer, Chemnitz, 2, 1894, 18; Bacillus violaceus berolinensis Kruse, in Flugge, Die Mikroorganismen, 3 Aufl . 2, 1896, 311, Bacterium lividus Chester, Ann Rept Del. Col. Agr Exp. Sta., 9, 1897, 117; Bacillus berolinensis Chester, Man Determ Bact., 1901, 305; Holland, Jour. Bact , 5, 1920, 215) From water

Chromobacterium maris-mortui Elazari-Voleani (Studies on the Microflora of the Dead Sea, Thesis, Hebrew Univ , Jerusalem, 1940, vii and 76) From the Dead Sea.

Chromobacterium membranaceum Bergcy et al. (Bacillus membranaceus amehystinus I, Bampton, Cent f. Bakt., I Abt., Orig., 71, 1913, 135; Bergey et al , Manual, 1st ed., 1923, 119; Chromobacterium membranaceum amethystinum I Ford, Textb. Bact., 1927, 472.) From water.

Chromobacterium membranaceum amethystinum III Ford. (Ford, Textb Bact., 1927, 474; Bacillus membranaceus amethystinus III Bampton, Cent. f. Bakt., IAbt., Orig., 71, 1913, 138.) From water.

Chromobacterium membranaceum amethystinum II Ford. (Ford, Tevtb. Ract., 1927, 474; Bacillus membranaceus amethystinus IV Bampton, Cent. f. Bakt., I Abt., Orig., 71, 1913, 138.) From water.

Chromobacterium smithii (Chester) Bergey et al. (Bacıllus cocruleus Smith, Medical News, 2, 1887, 758; Bacterium cocruleus Chester, Ann. Rept. Del. Col. Agr Exp. Sta., 9, 1807, 118; Pseudomona smithii Chester, Man. Determ. Bact., 1901, 318; Chromobacterium cocruleum Ford, Texth. Bact., 1927, 475; not Chromobacterium cocruleum Bergey et al., 1914, 121). From water.

Chromobacterium violaceum manilae
Ford. (Bacillus violaceum manilae
Ford. (Bacillus violaceus manilae
Ford. (Bacillus violaceus manilae
Hoy. U. S. Dept. Int., Bur. Govt. Labs
Bull. 15, 1904 and Bull. Johns Hopkins
Hosp., 16, 1905, 89; Ford, Tevtb. Bact,
1927, 471.) Isolated from fatal septice
misa in water buffalo (Woolley) and man
(Schattenberg and Harris, Jour. Bact,
44, 1912, 599). More likely to be a variety
of Chromobacterium ianthinum which
grows at 37°C. than of C. violaceum which
does not grow at 37°C.

Chromobacterium viscofucatum (Harrison and Barlow) Bergey et al. (Bacterum viscofucatum and Barlow, Cent. f. Bakt., 11 Abt., 18, 1905, 517; Trans. Royal Soc. Canada, 2nd Ser., 11, 1903; Bergey et al. Manual, 1st ed., 1923, 119) From oily butter Probably a non-motile Pseudomonas (Tobie, personal communication). Chromobacterium viscosum Grimes (Cent. f. Bakt., 11 Abt., 78, 1927, 367.)

From butter.

Pseudomonas pseudoviolacea Miguls.
(Syst. d. Bakt., 2, 1900, 943.) From

river water.

#### FAMILY V. MICROGOCCACEAE PRIBRAM.\*

#### (Jour. Baet., 18, 1929, 385)

Cells without endospores except in Sponsarema. Cells in their free condition spherical, during division somewhat elliptical Division in two or three planes. If the cells remain in contact after division, they are frequently flattened in the plane of last division. They occur singly, in pairs, tetrads, packets or irregular masses. Motility rare. Generally Gram-positive Many species form a yellow, orange, pink or red pigment. Most species are preferably aerobic, producing abundant growth on ordinary culture media, but capable of slight anaerobic growth. A few species are strictly anaerobic. Metabolism heterotrophic. Carbohydrates are frequently fermented to acid. Celatin is often hquefied. Facultative parasites and saprophytes. Frequently have on the skin, in skin glands or skin gland secretions of Vertebrata.

#### Key to the genera of family Micrococcaceae.

I. Cells occur in plates, groups or in irregular packets and masses, nover in chains. Pigment, when present, is yellow, orange or red. Gram-positive to Cramnegative.

Genus I. Micrococcus, p 235

- II. On the animal body and in special media cells occur as tetrads. In ordinary media cells may occur in pairs and irregular masses. White to pole yellow. Genus II Gaffka, p. 283
- III. Cells occur in regular packets Yellow or orange pigment usually formed Genus III. Sarcina, p. 285

### Genus I Micrococcus Cohn \*

(Cohn, Beitrage z Biol d Pflanzen, 1, Heft 2, 1872, 153, Microsphaera Cohn. Arch f. path Anat , 55, 1872, 237, pot Microsphaera Léveille, Ann Sei Nat Bot . Sér. 3, 16, 1851, 381; Ascococcus Colin, Beitrage z Biol d Pflanzen, 1, Heft 3, 1875. 154; Pediococcus Balcke, Wchnschr f Brauerei, 1, 1884, 183, Merista Van Tieghein. Tralté de Botanique, Paris, 1881, 1114, Staphylococcus Rosenbach, Mikroorganismen bel den Wundinsektions-kranklieiten des Menschen, 1884, 27, Monococcus Miller, Deutsch, nied Wehnschr, 12, 1886, No 8, 117; Botryomyccs Bollinger, Deutsch Zischr. f. Tiermed , 13, 1887, 77, Urococcus Miquel, Ann Microg , 1, 1898, 518; Galactococcus Cmillebean, Jahrb d Schweiz, 4, 1890, 32, Rhodococcus Zopf, Ber d deutsch Bot. Gesellsch., Berlin, 9, 1891, 28, Pyococcus Ludwig, Lehrb d niederen Kryptog. 1892, 27; Planococcus Migula, Arb Bakt Inst Karlsruhe, 1, 1891, 236, Carphococcus Hohl, Cent. f. Bakt , II Abt , 9, 1902, 335 , Albococcus Winslow and Rogers, Jour Int. Dis., 3, 1906, 541, Aurococcus Winslow and Rogers, abid, 540; Pedioplana Wolff, Cent. f Bakt , II Abt , 18, 1907, 9, Melococcus Nedrigailov, Charkov Med Zurnal. 4. 1907, 301; Solidococcus, Liquidococcus, Indolococcus and Peptonococcus Orla-Jensen, Cent. f. Bakt., 11 Abt., 22, 1009, 332, Planamerista Vuillemin, Ann. Mycol., 11, 1913, 525, Tetraceccus Orla-Jensen (in part), The Lactic Acid Bacteria, 1919, 76) I'rom Greek mierus, smill, coccus, a grain, M L . a sphere

Cells in plates or irregular masses (never in long chains or packets) Gram-positive to Gram-negative Growth on agar usually abundant, some species form no

<sup>\*</sup> The genera Micrococcus and Staphylococcus lave been combined and completely revised by Prof. G. J. Hucker, New York State Depriment Station, Geneva, New York, March, 1913 so far as the aerobic species are concerned. Dr. Ivan C. Hall, Presbyterian Hospital, New York Oty, revised the anacrobic section, January, 1914.

pigment but others form yellow or less commonly orange, or red pigment. Glucose broth slightly acid, lactose broth generally neutral. Gelatin frequently liquefied. but not rapidly. Facultative parasites and saprophytes.

The type species is Micrococcus luteus (Sebroeter) Cohn

# Key to the species of genus Micrococcus.

- 1. Acrobic to facultative anaerobic species.
  - I. No pink or red pigment on agar media.
    - A. Nitrites not produced from nitrates.
      - Utilize NH4H4PO4 as sole source of nitrogen.
        - a. Yellow pigment on agar roedia. Not acido-proteolytic.
        - 1. Micrococcus luteus. an. No pigment produced. Not acido-proteolytic.
          - b. Utilizes urea as a sole source of nitrogen.\*\*
            - 2. Micrococcus ureae.
            - bb. Does not utilize urea.
        - 3. Micrococcus freudenreichii.
        - ana. Acido-proteolytic in litmus milk.
      - 8. Micrococcus caseolyticus
      - Do not utilize NII<sub>t</sub>H<sub>2</sub>PO<sub>4</sub> as sole source of nitrogen. a. Yellow pigment produced.

        - 4. Micrococcus flavus. as No pigment produced.
          - 5. Micrococcus candidus.
    - B. Nitrites produced from nitrates.
      - 1 Utilize NH4H2PO, as sole source of nitrogen.
        - a. Yellow pigmeat on agar media. Not acido proteolytic.
          - b. Gelatin liquefied.
          - 6. Micrococcus conglomeratus. bb Gelatin not liquefied.
        - 7. Micrococcus varians. as Usually not chromogenic. Actively scide-proteolytic in litmus mulk.
        - 8. Micrococcus caseolyticus.
      - 2 Do not utilize NH4H2PO, as sole source of nitrogen.
        - a Gelatin liquefied Ferment mannitol. b. Abundant orange growth on agar media.
          - 9a. Micrococcus pyogenes var. aureus.
          - bb. Abundant white growth on agar media.
          - 9h. Micrococcus pyogenes var. albus bbb. Yellow growth on agar media.
            - 10. Micrococcus citreus.
        - as Gelatin not liquefied or very slowly liquefied.
          - b. Abundant orange to white growth on agar media Fermeats mannitol.
            - 11. Micrococcus aurantiacus.
          - bb. Scant white translucent growth on agar media. Does not ferment mannitol.

12. Micrococcus epidermidis.

\*\* Substitute 0.1 per cent urea for the ammonium phosphate in the above medium.

<sup>\*</sup>That is, will grow and produce acid (sometimes slowly) on slants containing 1.5 per cent washed agar, 0.1 per cent ammonium phosphate, 1.0 per cent glucose. 0.02 per cent potassium chloride, 0.02 per cent magnesium sulfate. Add brom-cresolpurple as an indicator (Hucker, N. Y. State Exper. Sta., Tecb. Bul. 100, 1921, 25; Tecb. Bul. 101, 1921, 36-40); Manual Pure Culture Study of Bacteria. Soc Amer. Bact., Geneva, N. Y., Leaffet II, 9th ed., 1944, 14.)

- Pink or red pigment on agar media.
  - A. Gelatin liquefied, slowly. Produces rose-colored pigment.
    - 13. Micrococcus roseus.
  - B. Gelatin not liquefied.
    - 1. Non-motile.
      - a. Produces cinnabar-colored pigment on gelatin.
        - 14. Micrococcus cinnabareus.
      - an Produces light, flesh-colored pigment on agar slant. Ferments glycerol and mannitol.
        - 15. Micrococcus rubens.

17. Micrococcus agilis.

- and. Produces brick-colored pigment on agar slant. Does not ferment glycerol and mannitol
- 16. Micrococcus rhodochrous.
- 2. Motile. Produces red pigment.
- 2. Anaerobic species.
- I. Forms gas from nitrogenous media.
  - A. Acid from plucose.
- 18. Micrococcus aerogenes
- B. No acid from glucose
  - No blackening of colonies in deep agar.
    - 19 Micrococcus asaccharolyticus, Deep agar colonies become black.
- 2 Hydrogen sulfide formed 20 Micrococcus niner
- II. No gas formed from nitrogenous media
  - A. Acid from glucose. 1 Acid from lactose

    - 2 No acid from lactose
- 21. Micrococcus grigoroffi.
- 22. Micrococcus anaerobius.
- 1. Micrococcus luteus (Schrocter) Cohn. (Bocteridium luteum Schroeter, Beitr. z Biol. d. Pflan , 1, Heft 2, 1872, 119; Cohn. ibid., 153 ) From Latin, luceus golden-vellow.
- Spheres: 1.0 to 1.2 microns, occurring in pairs and fours. Non-motile. Grampositive.
- Gelatin colonies: Yellowish-white to yellow, raised, with undulate margin.
- Gelatin stab · No liquefaction.
- Agar colonies : Small, yellowish, glistening, raised.
- Agar slant: Citron-yellow, smooth. Broth : Clear, with yellowish sediment.
- Litmus milk: Usually slightly acid, not coaculated. Potato: Thin, glistening, citron-yellow
- growth.
  - Indole not formed. Nitrites not produced from nitrates.

- Acid from glucose, sucrose and many nitol No acid from lactose.
  - Starch not hydrolyzed. Ammonia produced from peptone.
- Utilizes NH4H2 PO4 as a source of nitrogen.
  - Saprophytic.
  - Acrobic. Optimum temperature 25°C.
  - Source: Isolated by Schroeter from
  - dust contaminations on cooked potato. Habitat : Yound in skim milk and dairy
  - products, and on dust particles
- 2. Micrococcus ureae Cohn. (Cohn. Beitr. z. Biol. d. Pflanzen, 1, Heft 2, 1872, 159; not Micrococcus ureae l'lugge, Die Mikroorganismen, 2 Aufl., 1856, 169; Merista ureae Prazmowski, Biol. Cent., 8, 1888, 301; Streptococcus ureae

Trevisan, I generi e le specie delle Bat-

teriacee, Milan, 1889, 31; Urocaccus ureae Beijerinck, Cent. f. Bakt., II Abt., 7, 1901, 52; Albococcus ureae Kligler, Jour. Infect. Dis. 12, 1943, 442; Staphylococcus ureae Holland, Jour. Bact., 5, 1920, 225.) From Greek, urum, urine; M. L., urea, urea.

See Micrococcus liquefaciens Migula in the appendix for references to the gelatin-liquefying form of the species.

Spheres: 0.8 to 1.0 micron, occurring singly, in pairs and in clumps. Never in chains. Non-motile. Gram-variable.

Gelatin colonies . Small, white, translucent, slimy, becoming fissured.

Gelatin stab: Slight, white growth. Very slow or no liquefaction.

Agar colonies: White, slightly raised. Agar slant: Grayish-white, raised, glistening, butyrous.

Broth: Turbid, with viscid sediment. Litmus milk: Slightly alkaline; litmus slowly reduced.

Milk: Acid

Potato: Slight, grayish to pale olive growth.

Indole not formed.

Nitrates not produced from nitrates.

Urea fermented to ammonium carbonate.

Acid produced from glucose, lactose, sucrose and mannitol.

· Starch not hydrolyzed.

Ammonium salts are utilized Ammonia produced from peptone.

Saprophytic. Aerobic.

Optimum temperature 25°C.

Source: Isolated from fermenting urine. Habitat Found in stale urine and in soil containing urine.

3. Micrococcus freudenreichii Guillebeau. (Landwirtsch. Jahrb d. Schweiz, 5, 1891, 135) Named for E. v. Freudenreich, Swiss bacteriologist.

Synonyms: Micrococcus acidi lactis Krueger, Cent. f. Bakt, 7, 1890, 46 (Micrococcus acidi lactis liquefactens Eisenberg, Bakt. Diag, 3 Aufi., 1891, 409, Micrococcus acidi lactici liquefaciens Sternberg, Man. of Bact., 1893, 601; Micrococcus acidilactis Migula, Syst. d. Bakt., 2, 1900, 112; Micrococcus acidilcans Migula, ibid.); Micrococcus lacis viscous Sternberg, Man. of Bact., 1893, 601; Micrococcus amarifactens Migula, Syst. d. Bakt., 2, 1900, 100; Coccus lacis viscous Gruber, Cent. I. Bakt., II Abt., 9, 1902, 790 (Micrococcus lactis viscosi Gruber, Cent. I. Bakt., II Abt., 49, 1902, 790 (Micrococcus lactis viscosi Löhnis, Cent. f. Bakt., II Abt., 18, 1907, 141); Micrococcus lactis albidus Conn, Esten and Stocking, Storrs Agr. Exp. Sta. 18th Ann. Rent., 1906, 91.

Spheres: 2.0 microns in diameter, occuring eingly and in elumps, rarely in short chains. Non-motile. Gram-posi-

Milk gelatin colonies: Small, white, opaque.

Milk gelatin stab: Infundibultiorm liquefaction.

Agar colonies: White, slimy.

Agar streak: White, smooth. Broth: Turbid, with white sediment.

Litmus milk: Acid; congulated; peptonized.

Potato: Moderate white to yellow streak.

Indole not formed.

Nitrites not produced from nitrates. Starch not hydrolyzed.

Ammonia produced from peptone.

Does not utilize urea as a source of nitrogen.

Acid from glueose, lactose and sucrose Some strains form acid from mannitol; others from glycerol.

Saprophytie.

Aerobie. Optimum temperature 20°C.

Habitat: Milk and dairy utensils.

4. Micrococcus flavus Trevisan. (Micrococcus flavus liquefaciens Fluges, pie Mikroorganismen, 2. Aufi, 1886, 174; Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 34; Micrococcus flavus-liquefaciens Chester, Man. Determ. Bact, 1901, 90.) From Latin, flavus, Yellow.

Spheres: 0.8 to 0.9 micron, occurring

singly, in clumps, and occasionally in fours. Occasionally cultures are found that are motile with a single flagellum. Otherwise non-motile, Gmm-variable.

Gelatin colonies: Small, circular, Jellowish to yellowish-brown, somewhat serrate margin, granulated, sharply contoured.

Gelatin stab: Yellow, wrinkled surface growth with slow, crateriform liquefaction.

Agar colonies: Small, pale vellowish, homogeneous, entire.

Agar slant: Canary-vellow, somewhat dry, wrinkled, raised, entire.

Broth: Turbid with vellowish ring and rediment.

Litmus milk: Slightly acid, soft engulum formed, with slight reduction; slowly pentonized.

Potato: Slight, manary-yellow growth Indole is not formed.

Nitrites not produced from nitrates Starch not hydrolyzed.

Acid is generally formed from glucose and lactore. Sucrose, glycerol and mannitol generally not fermented

Ammonium salts are utilized Ammonia produced from peptone Non-mthogenic.

Acrobic.

Optimum temperature 25°C.

Source: Original source not given Habitat: Found in skin gland seemtions, milk, dairy products, and dairy utensile.

5. Micrococcus cendidus Colan (Cohn, Beitr. z. Biot. d. Pflanren, I. Helt 2, 1872, 160; Staphylococcus con frius Holland, Jour. Bart . 5, 1220, 221 ; From latin condition, alining whate

Fplicies: 0.5 to 0.7 micron, occurring singly. Non-motile. Gram penative Gristin referies Wiste, granular, with

ittrestar or eather rarem

Gelstin state, Wite surface growth Fildren, No liquefaction

Arm religies, Paperifores, white, sweath, entire, issiescent.

Agar slant: Smooth, white, glistening, iridescent.

Broth. Turbid, with pellicle.

Latmus milk: Slightly acid: not congulated. Potato:

Thick. porcelain glistening.

Indole not produced.

Nitrites not produced from nitrates. Starch not hydrolyzed.

Ammonia produced from penione.

Ammonium salts not utilized. Acid from glucose, sucrose, lactose

and glycerol.

Non-rathreenic. Acrobic.

Ontimum temperature 25°C.

Source. Originally appeared as white colonies on cooked potato exposed to dust contaminations.

Habitat: Found in skin secretions. milk and dairy products.

6 Microtoccus conglomeratus Migula. Diplococcus, Bumni, Citronengelber Der Mikroorganiemen der genorrheisellen Schleimbauterkrankurgen, 1 Aufl., 1885, 17. Hierococcus citreus conglomeratus Plugge, Die Mikmorranismen, 2 Auff. 1886, 182, Diplococcus extreus conclomeratta Bumm, and . 2 Auft . 1857 Neutrena estrea Trevisan, I generi e le specie delle Batteriacco, Milan, 1889, 32, Merumopetia eiteeus conglomeratus Dyar, Ann, N. Y. Acad. Sci., 8, 1995, 352, Migula. Syst d Bakt , 2, 1900, 116, not Micrococcus constancent is Weighterlinian, 1847. see Treviens, for cit, 33, Microscous externa Wirelow and Hanelon , Spetchatte Relational time of the Contrariate, 19th, 215 ). From India, a nelor crates, rolled trection enough

Spheres 08 to 12 micross, occurring singly, in pairs, in frace, and in large sheeps. Non-mobile. Gram sand le.

Gefaten erfmies Frigli, bircufar, gel. I'm with mil ste mare h.

Gelaum mater Slow erateral res Ligare. farters.

Agar colonies: Luxuriant, moist, sulfur vellow.

Agar slant: Light yellow, plumose, slightly rugose, somewhat dull, raised center and transparent margin.

Broth: Turbid, with light orange ring and sediment.

Milk: Generally acid but not sufficient to curdle.

Potato: No growth. Indole not formed.

Nitrites produced from nitrates.

Blood not hemolyzed.

Starch not hydrolyzed.

Acid from glucose and lactose gen-

crally, sometimes from sucrose. Mannitol and glycerol generally not fermented. Ammonia produced from pentone.

Utilizes NII,H2PO, as a source of nitrogen.

Resistant to drying and heat.

Non-pathogenic.

Aerobic.

Optimum temperature 25°C. Source: Found in generational pus and

Habitat: Infections, milk, dairy products, dairy utensils, water, common.

7. Micrococcus varians Migula. (Merismopedia flaw varians Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 346; Migula, Syst. d. Bakt., 2, 1900, 135; Merismopedia flawt-arians Chester, Man. Determ. Bact., 1901, 103; Micrococcus lactis varians Conn. Esten and Stocking, Storrs Agr. Exp. Sta Rept. for 1906, 121.) From Latin, varians varying.

Spheres: 0 8 to 1.0 micron, occurring singly, in pairs and in fours. Occasionally cultures are found that are motile with a single flagellum. Otherwise honmotile. Gram-variable.

Gelatin colonies: Small, circular, whitish to yellow, capitate, moruloid.

Gelatin stab . Scant growth. No lique-

Agar colonies Small, yellow, raised, glistening.

Agar slant: Plumose, yellow, variegated.

Broth: Turbid, with yellow, granular sediment. Litmus milk: Acid; coagulated on boil-

ng. Potato: Raised, dry, bright-yellow,

glistening.

Indole not formed.

Nitrites produced from nitrates.

Acid from glucose, Inctose, sucrose, raffinose and frequently from glycerol and mannitol. No acid from salicin or

Starch not hydrolyzed.

Ammonia produced from peptone.

Utilizes NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub> as a source of

nitrogen. Saprophytic.

Acrobic.

inulin.

Optimum temperature 25°C.

Source: Original strains found in a contaminated jar of sterilized milk.

Habitat: Has been found in holy secretions, dairy products, dairy utensils, dust and water, including sea water.

 Micrococcus caseolyticus Evans. (Evans, Jour. Inf. Dis., 18, 1916, 455; Micrococcus casei Hucker, N. Y. Agr. Evp. Sta. Tech. Bull. 102, 1024, 17; Probably Micrococcus casei Holland, Jour. Bact., 5, 1920, 223.)

Identical in part with Micrococcus castiacidoproteolyticus I and II Corini, Rev.
Cén. du Lait, 8, 1910, 387; Tétracoccus
liquefaciens Orla-Jensen, The Lactie
Acid Bacteria, 1919, 80 (Micrococcus castiqiuefaciens Orla-Jensen, Doktordispitats, 1904; Tetracoccus cassi liquefaciens
Orla-Jensen, The Lactic Acid Bacteria,
1919, 80; Micrococcus liquefaciens Holland,
Jour. Bact., 6, 1920, 224. Also see riserences under Streptococcus liquefaciens.)
From Latin, caseus, cheese, cascin; and
Grock, lyticus, able to dissolve; M. L.
dissolving, digesting.

Spheres, variable in size, occurring in clumps. Non-motile. Gram-positive.

Gelatin stah: Liquefaction generally

begins after first day and continues rapidly.

Agar colonies: Yellow to orange (Evans, loc ett.), pearly white (Hucker, loc, ett).
Agar stroke: Yellow to orange (Evans, loc. ett.), pearly white (Hucker, loc ett), luvuriant growth.

Broth Generally grows with smooth turbidity although certain strains give heavy precipitate with clear supernatant fluid.

Litmus milk: Acid, peptonized Whey generally clear. Potato: Scanty white growth Certain

strains may show yellow pigment
Indole not formed.

Nitrites usually produced from m-

trates.
Acid from glucose, lactose, maltose,

nannitol and glycerol No action on raffinoso
Forms dextrorotary factic acid (Orla-

Jensen, 1919, loc. ett).
Asparagin and urea decomposed by

some strains
Utilizes NH, H, PO, as a source of natro-

gen.

Optimum teroperature 22°C.

Aerobie. Saprophytie.

Source: Eight cultures from bovine

Habitat: Milk and dairy products, especially choose, dairy utensils

9a. Microoccus pyogenes var aurens (Rosenbach) Zopf (Staphylococcus pyogenes aureus Rosenbuch, Mikroorganismen hei den Wundinfectionskrankheiten des Menschen, Wiesbuden, 1881, 19, Staphylococcus aureus Rosenbach, bud. 27, Microoccus pyogenes var aureus Zopf, Die Spatipilie, 3 Auf, 1885, 56, Micrococcus aureus Zopf, ibid., 57, Micrococcus aureus Zopf, ibid., 57, Micrococcus aureus Zopf, ibid., 57, Micrococcus aureus Winslow and Rogers, Jour Int Dis., 5, 1005, 551, Nicrococcus aureus Winslow and Rogers, Jour Int Dis., 5, 1005, 551, Nicrococcus lactis caranas Cone, Taten and Stocking, Storra Agr. Fup Sta Rept for 1906.

121; Staphylococcus pyogenes Andrewes and Gordon, Rept (35th) Med. Officer Local Govt Board, London, 1907, 549; (Tetracoccus) Micrococcus pyogenes aureus Orla-Jonsen, The Lactic Acid Bacteria, 1919, 81, Staphylococcus pyogenes-aireus Holland, Jour. Bact, 6, 1920, 223) From Greek, pyon, pus; Mi, genes, producing From Latin, aureus, golden

Spheres: 0 8 to 1.0 micron, occurring singly, in pairs, in short chains, and in irregular elumps Non-motile Grampositive.

Gelatin stah. Saccate liquefaction with yellowish pellicle and yellow to orange

sediment.
Agar colonies: Circular, smooth, yellowish to orango, glistening, hutyrous,

entire.
Agar slant: Ahundant, opaque, smooth,

flat, moist, yellowish to orongo.

Broth Turbid with yellowish ring and

sediment, becoming clear.

Litmus roilk. Acid, congulated.

Litmus rollk. Aeld, congulated. Potato: Ahundant, orange, glistening.

Indole not formed Nitrites produced from nitrates.

Acid from glucose, lactose, sucrose,

mannitol and glycerol, hut not from raffinose, saliein or inulin.

Forms inactive or levorotary lactic acid (Orla-Jensen, loc. cit ).

Slight II,S formation

Starch not hydrolyzed.

Does not utilize NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub>, as a source of pitrogen

Ammonia produced from peptone

Pathogeme. Individual strains vary in their ability to produce hemolysin, coagulase and other metabolic products. Certun strains, under favorable conditions, produce not only evotovins (hematovin, dermatovin, lethal toxin, etc.) but also a potent enterotovin which is a significant cause of food posoning (Dolman and Wilson, Jour Immunology, 55, 1933, 130).

Aerobic, facultative

Optimum temperature 37°C.

Source: Isolated from pus in wounds

Habitat: Skin and mucous membranes. The cause of boils, abscesses, furuncles suppuration in wounds, etc.

9b. Micrococcus pyogenes var. albus (Rosenbach) Schroeter. (Staphylococcus pyogenes albus Rosenbach, Mikroorganismen bei den Wundinfektionskrankheiten des Monschen, Wiesbaden, 1884, 2: Staphylococcus albus Rosenbach, 1bid., 27; Micrococcus pyogenes var. albus Schroeter, in Cohn, Kryptog. Flora v. Schlesien, 3, 1, 1886, 147; Micrococcus pyogenes Migula, Syst. d. Bakt , 2, 1900, 87; Albococcus pyogenes Winslow and Rogers, Jour Inf Dis , 3, 1906, 544; Micrococcus albus Buchanan, Vetermary Bacteriology 1911, 196; (Tetracoccus) Microccocus pyogenes albus Orla-Jensen, The Lactic Acid Bacteria, 1919, 81, Staphylococcus pyogenes-albus Holland, Jour. Bact., 5, 1920, 225.) From Latin, albus, white.

Spheres: 0.6 to 0.8 micron, occurring singly, in pairs and in irregular groups. Non-motile Gram-positive.

Gelatin stab: Saccate liquefaction with heavy white sediment.

Agar colonies: Circular, white, smooth, glistening, entire.

Ten per cent evaporated milk agar. Growth at 20°C frequently orange

(Chapman, Jour. Bact, 45, 1943, 405) Agar slant: Abundant, white, smooth, glistening.

Broth: Turbid, with delicate pellicle and white sediment.

Litmus milk: Acid; coagulated. Little or no visible peptonization.

Potato: Thick, smooth, white, glistening.

Indole not formed.

Nitrites produced from nitrates Hydrogen sulfide is formed.

Acid formed from glucose, lactose, sucrose, glycerol and mannitol, but nnt from raffinose, salicin and inglin

Forms inactive or levorotary lactic acid (Orla-Jensen, loc. cit.).

Starch not hydrolyzed.

Ammonia produced from peptone. Does not utilize NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub> as a source of nitrogen. Pathogenic. Production of toxins, coagulase and hemolysin as in Micrococcus aureus.

Aerobic, facultative.

Optimum temperature 37°C.

Source: Originally isolated from our. Habitat: Skin and mucous membranes Occurs in wounds, boils, abscesses, etc.

10. Micrococcus citreus Migula. (Staphylococcus pyogenes citreus Passet, Actinlogie der eiterigen phlegmone des Menschen, Berlin, 1885, 9; Micrococus pyogenes citreus Schroeter, in Colon, Kryptog. Flora v. Schlesien, 3, 1, 183, 147; Migula, Syst. d. Bakt., 2, 1900, 147; Staphylococcus citreus Bergey et al., Manual, 1st ed., 1923, 55.) From Latin, citreus, of or relating to the citrus tree; M. L., lemon yellow.

Spheres: 0.9 micron, occurring singly. Gram-positive.

Gelatin colonies: Circular, pale yellow, granular, entire, liquefying in 6 days.

Gelatin stab: Lemon yellow surface growth sinking into the medium. Grayish-white growth in stab. Complete liquefaction in 43 days.

Agar colonies: Small, yellow, smooth, entire.

Agar slant: Broad, lemon yellow, glistening, clastic. Broth: Turbid, with yellow sediment

and pellicle.
Litmus milk: Acid, with slow coagula-

Litmus milk: Acid, with slow coagan

Potato: Thin, grayish streak, becoming citron vellow.

Indole not formed.

Nitrites produced from nitrates. Starch not hydrolyzed.

Acid from glucose, lactose, sucrose, raffinose, inulin, salicin, glycerol and mannitol.

Does not utilize NH4H2PO4 as a source of nitrogen.

f nitrogen.

Ammonia produced from peptone.

Aerobic, facultative.

Pathogenic.

Optimum temperature 37°C. Source: Originally isolated from pus.  Habitat: Skin and mucous membranes of vertebrates

11. Micrococcus aurantiacus (Schroeter) Cohn. (Bacteridium aurantiacum Schroeter, Beitr. z. Biol., 1, Heft 2, 1872, 126; Cohn, Beitr, z. Biol , I, Heft 2, 1872, 151: Pediococcus aurantiacus De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1051; Micrococcus aurantiacussorghi Bruyning, Arch, Néer Sci Exact. ct Nat., 1, 1893, 297, Streptococcus aurantiacus Chester, Man. Determ Bact., 1901, 69; Aurococcus aurantiacus Winslow and Winslow, Systematic Relationships of the Coccaccae, 1903, 186; Sarcina aurantiaca Holland, Jour Bact, 5, 1920, 225 (not Sarcina aurantiaca Flugge, Die Mikroorganismen, 2 Aufl., 1886, 180), Staphylococcus aurantiacus Holland, sbid ) From Latin, aurum, gold, M. L , aurantium, the orange, M L , aurantiacus, orange-colored.

Spheres: Slightly ellipsoidal, 1 3 to 1 5 microns, occurring singly, in short chains and in small clumps. Non-motile Gram-positive.

Gelatin colonies: Circular to oval, smooth, glistening with yellow to orange center.

Gelatin stab: Yellow surface growth No liquefaction.

Agar colonies. Circular, smooth, glistening, yellow to orange, entire.

Agar slant: Buff to scant orange-yellow, beaded growth, raised, glistening.

Broth: Turbid, with pellicle

Litmus milk. Faintly acid, no coagu-

lation.

Potato: Slimy, yellow growth. Pigment is insoluble in alcohol and other

Indole not produced.

Nitrites generally produced from ni-

trates.
Slight acidity from glucose, fructose,

sucrose, lactose and mannitol No acid from raffinose, salicin, inulin Starch not hydrolyzed.

Ammonia produced from peptone No growth in ammonium media.

May be pathogenic. Optimum temperature 25°C Aerobic.

Source: First isolated from colonies that grew on boiled egg exposed to dust contamination.

Habitat: Usually isolated from infections but also found in milk, cheese and dust.

Note: Albococcus epidermidis (var. A) Kligler (Jour. Infect Dis., 12, 1913, 441) which was based on a white culture received from Kral under the name Micrococcus curantiacus was apparently a white strain of this organism as it grew luvuriantly on ordinary acti

12. Microsoccus epidermidis (Winslon and Winslow) Hucker (Scippylococcus epidermidis albus Welch, Amer Jour, of Med Sci, Phla, N. S., 102, 1801, 441, Microsoccus epidermidis albus Randolph, Jour Amer Med, Assoc., 51, 1898, 700, Albooccus epidermidis winslow and Winslow Syst. Relationships Cocaceae, New York, 1903, 201, Staphylococcus epidermidis Evans, Jour. Inf. Dis. 15, 1916, 449, Hucker, N. Y. Agr. Exp Sta. Tech Bull 102, 1921, 21.) From Greek, epidermis, tho outer skin

Spheres 0.5 to 0.6 micron, occurring singly, in pairs and in irregular groups Non-motile. Gram-positive.

Gelatin stab. White surface growth with slow saccate liquefaction

Agar colonies. Rather scant, white, translucent.

Broth: Turbid, with white ring and sediment.

Litmus milk. Acid

Potato · Lamited growth, white.

Indole not formed.

Nitrites are produced from nitrates. Usually does not utilize NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub> as a source of nitrogen

Acid formed from glucose, fructose, maltose, lactore and sucrose, but not from mannitol, raffinose, salicin or multi.

Usually fails to hemolyze blood N congulase produced.

Parasitic rather than pathogenic. Aerobic, facultative, Optimumtemperature 37°C.

Source: Originally isolated from small stitch abscesses and other skin wounds. Habitat: Skin and mucous membranes.

13. Micrococcus roseus Flugge. (Rosafarbiger Diplococcus, Bumm, Der Mikroorganismen der gonorrhoischen Schleimhauterkrankungen, 1 Aufl., 1885. 25; Flugge, Die Mikroorganismen, 2 Aufl., 1886, 183; Neisseria rosea Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 32; Diplococcus roseus Eisenberg, Bakt. Diag , 3 Aufl., 1891, 12, Merismopedia rosea Dyar, Ann. N. Y. Acad Sci , 8, 1895, 351, Rhodococcus roseus Winslow and Rogers, Jour Inf Dis., 5, 1906, 545.) From Latin, roseus, rosecolored.

Spheres: 1.0 to 1.5 microns, occurring singly and in pairs. Non-motile. Gram-

Gelatin colonies Rose surface growth usually with slow liquelaction.

Agar colonies · Circular, entire, rosered surface colonies.

Agar slant. Thick, rose-red, smooth, glistening streak.

Broth: Slightly turbed with rosecolored sediment.

Litmus milk: Unchanged to alkaline, usually reddish sediment after 14 days. Usually produce nitrites from nitrates. Potato: Raised, rose-red, smooth, glis-

tening. Starch not hydrolyzed.

Starch not hydrolyzed.

Acid from glycerol and mannitol

Utilizes NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub> as a source of nitrogen.

Saprophytic

Aerobic Optimum temperature 25°C

Source: Dust contamination

Habitat Widespread, as it occurs in dust.

14. Micrococcus cinnabareus Flugge. (Flugge, Die Mikroorganismen, 2 Aufl., 1886, 174, Rhodococcus cinnabareus Winslow and Rogers, Jour Inf Dis., 5, 1906, 545.) From M. L., cinnabar-colored.

Spheres: 1.0 micron, occurring singly and in pairs. Non-motile. Gram-variable.

Gelatin colonies: Small, circular, bright red, becoming cinnabar red.

Gelatin stab: Thick, raised, rose to cinnabar red growth on surface. No liquefaction. White colonies along stab. Agar slant: A carmine-red streak.

Slow growth.

Broth: Turbid.

Litmus milk: Slightly alkaline to slightly acid.

Potato. Slowly developing vermillion red streak.

Small amount of acid from test sugars. Indole not formed.

Does not utilize NH4H2PO4 as a source of nitrogen.

Nitrites produced from nitrates.

Starch not hydrolyzed.

Saprophytic.

Aerobic. Optimum temperature 25°C.

Source. Found as contamination of

Habitat: Usually found as a dust contamination

15. Micrococcus rubens Migula. (Micrococcus tetragenus ruber Bujwid, in Schneider, Arb. bakt. Inst. Karlsruhe, I. Heft 2, 1894, 215; Migula, Syst. d. Bakt., 2, 1900, 177; Micrococcus ruber and Rhodococcus ruber Holland, Jour. Batt, 6, 1920, 224; Micrococcus roscofultus Hucker, N. Y. S. Agr. Exp. Sta. Tech. Bull. 135, 1928, 27; not Micrococcus roscofultus Lehmann and Neumann, Balting, 1, 1806, 177 and 439; Rhodococcus roscofultus Pribram, Klassifiation der Schizomyceten, 1933, 44). From Latin, rubens, ruddy.

The following description is taken from Migula (loc. cit.) and from Hucker (loc cit) supplemented from unpublished notes of the latter. Also see Breed (Jour-Bact., 45, 1913, 455).

Spheres: 1.3 to 40 microns, average size 21 microns, occurring in fours and

in irregular masses, generally not singly or in pairs. Non-motile. Gram-negative to Gram-variable

Gelatin colonies: After several days, small, pink or flesh-colored, shury, butyrous, 0.5 to several mm. in dameter. Smaller colonies have regular edges, larger colonies have lobate edges.

Gelatin streak: Thick, shiny, fleshcolored to carmine-red growth, generally spreading.

Gelatin stab: Scant, whitish growth along line of stab; surface growth fleshred. No liquefaction after several weeks, but a slight softening of the medium underneath the growth.

Agar slant: Luxuriant, thick, spreading, slimy, ficsh-colored growth.

Broth: Bright red, slimy sediment. No pellicle.

Milk: Generally acid curd followed by slight peptonization.

Nitrites produced from nitrates

Acid from glucose, sucrose, mannitol and glycerol No action on lactose or starch.

Pigment soluble in ether, benzol, carbon bisulfide, chloroform and alcohol Not soluble in water (Schneider, loc cil.).

Saprophytic.

Grows well at 26° to 37°C.

Aerobic.

Source. Original culture isolated by Bujwid in Bern, Switzerland and sent to Migula at Karlsruhe, Germany

Habitat · Unknown.

Micrococcus rhodochrous (Zopf) Migula. (Rhodococcus rhodochrous Zopf.)
 Berichte d. deutsch. bot Gesellsch. 9, 1891, 22; Migula, Syst. d. Bakk., £, 1900, 162.)
 From Greek, rhodum, rose; chros, color.

Spheres: 0 5 to 1 0 micron, occurring singly. Non-motile. Gram-variable.

Gelatin colonics: Small, circular, glistening, raised, entire, dark, reddishbrown. Gelatin stab. Dork, carmine-red, dry surface growth. Slight growth in stab. No liquefaction.

No liquefaction.

Agar slant: Carmine-red streak, becoming brick-red in color.

Broth: Thick rose-red pellicle with red, flocculent sediment.

Litmus milk. Slightly alkaline. Potnto: Carmine-red streak.

Does not ferment glycerol and man-

Aerobic.

Saprophytic. Optimum temperature 25°C

Habitat. Water.

17. Micrococcus agilis Alı-Cohen. (Ali-Cohen, Cent. f. Bakt , 6, 1889, 36; Planosarcina agilis Migula, in Engler and Prantl. Die natur! Pflanzenfam., 1. la, 1895, 20, Micrococcus agilis ruber Peppler, Cent. f. Bakt., I Abt , 29, 1901, 352. Planococcus agilis Chester, Man. Determ. Bact., 1901, 115, Rhodococcus agilis Winslow and Ropers, Jour. Inf. Dis . 3. 1906, 545; Sarcina agilis Enderlein, Sitzber Gesell. Naturf. Freunde Berlin, 1930, 182; not Sarcina agilis Matzuschita, Zeit. f. Hyg., 55, 1900, 496; not Sarcina ogilis Saito, Jour. Coll. Sci Imp. Univ Tokyo, 25, 1909. From Latin, ogilis, agile. Spheres, 10 micron, occurring singly,

Spheres, 10 micron, occurring singity, in pairs and in fours. Motile by means of one or two flagella. Gram-variable. Gelatin colonies: Small, gray, becoming

distinctly rose-colored.

Gelatin stab Thin, whitish growth in stab On surface thick, rose-red, glutening growth. Generally no liquefaction.

Agar slant: Glistening, dark rose-red, lobed, much variation in color.

Broth: Shightly turbid, with slight, rose-colored ring and pink sediment.

Litmus milk Slightly acid, pink sediment.

Potato. Slow growth as small, rosecolored colonies.

Loeffler's blood serum: Pink, spread-

ing, shiny, abundant. Slow liquefaction.

Indole not formed.

Nitrites produced (trace). Ammonia formed (trace).

Does not utilize NII4H2PO4 as source of nitrogen

Acid from glucose, sucrose, inulin, glycerol and mannitol No acid from raffinose.

Aerobie.

Saprophytic.

Optimum temperature 25°C.

Source: Isolated from water. Habitat · Water, sea water, on sea fish

\*18. Micrococcus nerogenes (Schottmuller) Bergey et al. (Staphylococcus aerogenes Schottmuller, Cent f. Bakt., 1 Abt., Orig , 64, 1912, 270; Bergey et al., Manual, 1st ed., 1923, 70, not Micrococcus Miller, Deutsch acrogenes Wehnsehr., 12, 1886, 119.) From Greek, forming air or gas.

Description according to Prévot, Ann Sci. Nat., Ser. Bot et Zool., 15, 1933, 212 Spheres: 0.6 to 0.8 micron, occurring

in clusters, sometimes in pairs or short chains. Gram-positive.

Gelatin: No liquefaction.

Deep agar colonies: Small, lenticular, nearly spherical, yellowish white. Some gas bubbles produced, not fetid.

Blood agar colonies: Very small, grayish. No true hemolysis, but n narrow clear zone is formed.

Serum agar: Colonies lenticular Gas not fetid.

Neutral red serum agar Colonies lenticular. Gas produced. Neutral red changed to greenish vellow.

Glucose broth with blood: Turbid. Gas produced. Hydrogen sulfide not produced Slight hemolysis.

Glucose serum broth: Turbid. Gas

Peptone water with scrum Gas. Indole produced.

Milk: Growth feeble Neither seid nor coagulated.

Proteins not attacked.

Glucose and fructose attacked slightly by two out of three strains.

Does not plasmolyse readily.

Neutral red broth: Changed to vellowish green.

Nitrites not produced from nitrates

Optimum plI 6.5 to 80.

Optimum temperature 37°C. Pathogenie.

Strict anacrobe.

Distinctive character: Fermentation of glucose and gas production from peptones.

Source: Isolated (Schottmüller) from cases of puerperal fever. Three strains

from infected tonsils studied by Prevot. Habitat: Natural cavities, especially the tonsils and female genital organs

 Micrococcus assecharolyticus (Distaso) comb. nov. (Staphylococcus asaccharolyticus Distaso, Cent. f. Bakt, I Abt., Orig., 62, 1912, 415 ) From Greek, not dissolving sugar.

Description according to Prévot, Ann. Sci. Nat., Ser. Bot., 15, 1933, 211.

Large spheres: 1.0 to 1.2 microns, occurring in very large clusters, also in pairs and short chains. Gram positive.

Gelatin: At 37°C, growth resembles tufts of cotton which precipitate. No liquefaction.

Deep agar colonies: Very delicate, pin-point, transparent. A few bubbles of gas produced.

Broth: Turbid. Growth settles at the bottom of the tube as a sort of viscous zooglea. Unpleasant odor produced.

Peptone water: Turbid. Indole produced.

Milk: Feebly acidified, but not coagulated.

Egg white not attacked. Carbohydrates not attacked. Strict anaerobe.

<sup>\*</sup> Anaerobic section revised by Dr Ivan C. Hall, New York, N. Y.

Distinctive characters: Large size; unpleasant odor; production of indole: production of gas.

Source: Isolated from the large intestine of a man with intestinal intoxication.

Habitat: Intestine. Not common

Note: Weinberg, Nativelle and Prévot (Les Microbes Annérobies, 1937, 1023) regard Micrococcus indolicus Christiansen (Ac. Pat. Mier, Scand , 18, 1931, 42) as a variety of this species giving it the name Staphylococcus asaccharolyticus var indulicus. This variety differs from the species by forming opique lens-shaped colonies and by a more abundant production of gis from pentone

20. Micrococcus niger tiali (Jour Bact., 20, 1930, 409 ) From Latin, niger, hlack.

Small spheres · 0 6 micron in diameter. occurring in irregular masses, occasion illy in mirs. Gram-positive

Gelatin: After 5 days a dark seduncat is produced which gradually gets more and more intensely ldack. No hourfartion.

Deep agar colonies Slow growth first very tiny, colorless, irregularly globular, smooth, dense Small bubbles of gus sometimes produced. Mar sev. eral days colonies become brown, then black. If exposed to air, colonies fule to a dull gray. Medium not discolared

Blood agar shart Mer 1 or 5 days namute, black colonies, round, sureth. ghetening, 0.5 mm, in deameter Nonbetwell tie.

Broth: After I or 5 days uniform fur bidity and slight production of gre which contains II, S. Black sectiment

Congulated serom Minute, brown colonies appear on the 5th day 50 liquefacti in

Mdk No clance

Brain a churn Turbid after for Solars at 37°C. Uniform was production about the 6th day. Then beginn of the me dram not marked

No acid from carbohydrates. Black sediment produced.

Non-pathogenie for guinea-pigs and rabbits.

Optimum temperature 37°C, No growth below 30°C.

Strict appembe.

Distinctive characters: Pormation of a . water-meduble, black pigment. Growth slow, visible after 2 to 4 days.

Source: Isolated from urine of an aged woman.

Habitat: Unknown.

2f. Micrococcus grigoroffi Prévot. (Micrococcus A. Grigoroff, Thèse de Geneve, 1905; Prévot, Ann. Sci. Nat., Ser Bot. et Zool , 15, 1933, 219.) Named for Gricoroff, who first isolated this organism.

Small spheres: Average size 0.7 micron. occurring eingly or in irregular masses. Gram-positive.

Gelatin Colonies appear in four days No houghetton.

Deep ager colonies: After three days. mund, lenticular, yellowish

Glucose broth Turbul after 2 days with whitish sediment Neither gas nor lette oder produced The medium 14 aculified.

Milk; Good growth Acid, Congufatton

Acid from glucose, maltose, lactose, fructure and workitol

One strain slightly inthogenic

Optimum temperature 37°C

Strict aparrobe Distinctive characters. This is the

only anaember corrus rowing in irregular masses that engulates milk | Lactore is fermented Source Five strains is dated from the

amends by Gazoroff. One strain isolated from an appendix by Privot.

Habitat Human digestive tract common

22 Mittrococcus saserobius (llamm) and nor (Araerolic stapla) roccus Jurgero, Compt trud See Bed Paris, 59, 1997, 707; Stay Islandens angerolius

Hamm, Die puerperale Wundinsektion, Berlin, 1912, not Staphylococcus anaerobius Heurlin, Bakt, Unters. d. Keimgehaltes im Genitalkanale d. fiebernden Wöchnerinnen, Helsingfors, 1910, 120.) From Greek, living without air.

Description according to Prévot, Ann. Sci. Nat., Sér. Bot., 15, 1933, 209.

Small spheres: 0.5 to 0.6 micron, occurring in masses. Gram-positive. Gelatin: No liquefaction.

Deep agar colonies: Lenticular, thick. No gas produced.

Broth: Turbid, later clearing. Sediment.

Glucose broth: Good growth. Neither acid nor gas produced. Pentone water: No turbidity. No

gas. Indole not produced. Milk: Neither coagulated nor acidified.

Coagulated serum not attacked. Egg white not nttacked.

Carbohydrates not attacked by the strains of Jungano. Acid feebly produced from glucose and galactose by Prévot's strain.

Does not plasmolyse.

Temperature relations: Optimum 36° to 38°C. At 22°C growth slow, poor. No growth below 22°C, Killed in ten minutes at 80°C or in half an hour at 60°C.

Optimum pH 60 to 8.0.

Pathogenic for guinca-pigs rabbits.

Strict anaerobe.

Distinctive characters: Neutral red broth remains unchanged. No gas produced.

Source: First isolated by Jungano from a case of cystitis. Found by Prévot in the pus from a suppurated tonsil.

Habitat: Urinary tract, urethra, intestine, buccal envity and conjunctiva

Appendix I\*: The following genus is organized on a physiological basis. Because of this no attempt is made to fit it into the classification outline. A single species has been described.

> Genus A. Methanococcus Kluyrer and von Niel. (Cent. f. Bakt., II Abt., 94, 1936, 400.)

Spherical cells, occurring singly or in masses. Motility not observed. No endospores formed. Gram-variable. Chemo-heterotrophic, angerobic, fermenting various organic compounds with the formation of methane. Saprophytes.

The type species is Methonococcus mazer Barker.

1. Methanococcus mazel Barker. (Pseudosarcina, Mazé, Compt rend. Soc. Biol., Paris, 78, 1915, 398; Barker, Arch. f Mikrobiol., 7, 1936, 430 ) Named for Mazé, the French bacteriologist who first gave a clearly recognizable description of this type of methane organism.

Small spherical cells, occurring singly, in large, irregular masses, or in regular cysts of various sizes and forms. Nonmotile. Stains readily with erythrosine. Gram-variable

Grows on calcium acetate enrichment media and ferments the acctate vigor-

Grows slowly on agar containing 2 per cent clear mud extract.

Ferments acetic and butyrie acids with production of methane in the presence of CO2 Ethyl and butyl alcohols not attacked.

Does not utilize organic nitrogen. Obligate anaerobe.

Grows best at 30° to 37°C.

Sources: Garden soil, black mud containing H2S, feces of herbivorous animals.

Habitat: One of the most active methane-producing organisms found in nature,

<sup>\*</sup> Appendixes I and II prepared by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, December, 1943.

Appendix II: The following genus is recognized by workers in the brewing industry. It includes species that present characters intermediate between Micrococcus, Sarcina and Strepleocecus Many atudents prefer to regard these as species of Micrococcus (Hucker, N. Y. State Exper. Sta, Tech Bul. 102, 1921, 5), of Sarcina (Mace, Traité pratique d. Bact., 4th ed., 1901, 460) or of Streptococcus (Shimwell, Sect. 670 in Hind, Brewing Science and Practice, New York, 1940). Others (Mecs, Thesis, Delft, 1931) would include in the genus, the species described as Tetracoccus by Orla-Jensen (The Lactic Acid Bactera, Copenhagen, 1919, 76).

Genus B. Pedlococcus Balche (Webnschr, f. Brauerci, 1, 1884, 257.)

Cocci occurring singly, in pairs and tetrads. Non-motile. No endospores. Grampositive. Facultative anarobes under favorable conditions, especially in acid media. Nitrites not produced from nitrates. Produce acidification and more or less clouding of wort and beer. Suprophytes.

The type species is Pediococcus cerevisiae Baleke.

I. Pediococcus cerevisiae Baleke. (Ferment No. 7, Tasteur, Études sur la bière, Paris, 1876, 4; Sarcina Baleke, Wehnsehr. f. Braucret, f. 1831, 183; told f., 1831, 237; Merismopedia cerevisiae Dyar, Ann. N. Y. Acad Sci. 8, 1895, 318; Micrococcus ceretinae Ahigula, Syst d Bakt, 2, 1000, 77; Sarcina cerevisiae Macé, Traité Pratique d Bact, 4th ed. 1901, 400). From Latin, ceretisia, beer

Spheres: 1 to 1.3 microns, occurring singly, in pairs or tetrads. In acid media the latter prevail. Catalase negative. Non-motile. Gram-positive

No growth in alkaline media.

Peptone, ment-extract gelatin. White becoming yellowish to yellowish brown. No liquefaction.

Wort gelatin with Ca-carbonate: White colonies, 2 to 3 mm; carbonate dissolved

Meat extract gelatin stab: Growth along stab, white raised surface growth No liquefaction.

Litmus milk: No growth.

Potato: Scanty growth.

Acid from glucose, fructose, maltose, sucrose.

Wort and beer Slight to moderately turbid growth, strong development on bottom of the flask. Hop sensitive, but may develop in heavily hopped beers under special conditions. Does not utilize urea.

Nitrites not produced from nitrates. Facultative suncrobic.

Killed at 60°C in 8 minutes. Optimum temperature: 25°C.

Source: Sarcina sick beer.

Habitat: Wort, beer and beer yeast.

Additional species have been described from spolicd wort and beer which vary but slightly from the species first named and described by Baleke. These are hated below together with other species that have been placed in the genus. Pedvoccesus acquidation Lindner.

(Lindner, Welmschr. f. Brauerei, S., No. 23, 1887, see Cent. f. Bakt., g., 1887, 312; also see Die Sareina-Organismen der Gährungrgewerbe, Lindner, Inaug. Dass, Berlin, 1883, 20, and Cent. f. Bakt., f. 1883, 421; Microcecus pseudocercusiae Migula, Syst. d. Bakt. g., 1900, 77; Microcecus acudi Jactici Chester, Man. Determ. Bact., 1901, 83 ) From spoiled mash

Pediococcus albus Lindner. (Die Saccina-Organismen der Gährungswerber, Lindner, Inaug. Diss., Berlin, 1887, 39; see Cent. I. Bakt., 4, 1883, 429; Micrococcus pseudosterna Migula, Syst. d. Bakt., 2, 1900, 92; Micrococcus albus Cheeter, Man Determ. Bact., 1901, 97.) From popiled beer.

Pediococcus damnosus Claussen.

(Compt. rend. Trav. Labor. de Carlsberg, 6, 1906, 68; Streptococcus damnosus Shimwell and Kirkpatrick, Jour. Inst. Brewing, 45, 1939, 137.) From clear, spoiled beer.

Pediococcus halophilus Mecs. (Tetracoccus No. 1, Orla-Jensen, The Lactic Acid Bacteria, 1919, 77; Mecs, Thesis, Delft, 1934, 94.) From anchovy pickle.

Pediococcus hennebergi Sollied. (Ztsehr. Spiritusindus., 26, 1903, 491.) From spoiled beer.

Pediococcus kochii Trevisan. (Mikrokokkus in Wundsecreten bei Menschen, Koch; Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 28.)

Pediococcus peniosaceus Mees. (Tetraeoccus No. 2, Orla-Jensen, The Lactic Acid Bacteria, 1919, 78; Mees, Thesis, Delft, 1934, 94.) From yeast.

Pediococcus perniciosus Claussen (loc. cit.). From clouded, spoiled beer.

Pediococcus sarcinaeformis Reichard. (Ztschr. f. d. gcs. Brauwescn, 17, 1894,

237.) From spoiled beer. Pediococcus urinae equi Mees. (Pferdeurinsarcina, von Huth, Alg Zig. f Bierber u. Malsfabr, 185, 968 and 981, 1885; ibid., 1836, 141; Mees, Theiss, Delft, 1034, 95.) From horse urine.

Pediococcus violaceus (Kutzing) Trevisan. (Merismopedia violacea Kutzing; Trevisan, I generi e le specie delle Bat-

teriacee, Milan, 1889, 28.)

Pedioplana haeckeli Wolff. (Cent. f Bakt., II Abt., 18, 1907, 9.) Motile. From rotting beets. Placed in a new genus Pedioplana Wolff (loc. cit., 9).

Stieptococcus damnosus var. mucosus Shimwell. (Shimwell, Sect. 670, Hind, Brewing Science and Practice, New York, 1940.) From ropy beer.

Appendix III\* The following species have been found in the literature and are listed here chiefly for their historical interest. Many are incompletely described, while many others are identical with previously described species. See Monographs by Winslow and Winslow, Systematic Relationships of the Cocceccae, 1908 and Hucker, N. Y. State Exper. Sta., Tech. Buls. Nos. 99-103. References are to Tech. Bul. 102.

Ascococcus cantabridgensis Hankın. (Quoted from Lehmann and Neumann, Bakt. Diag., 2 Aud., 2, 1899, 165.) Migula (Syst. d. Bakt., 2, 1900, 193) reports he is unable to find further reference to this organism and we likewise are unable to trace it. From the human mouth.

Ascococcus gangrenosus Beyan. (Med. News, No. 1003, 1892, 375; Abst. in Cent. f. Bakt., 18, 1893, 796.) From a gan-

grenous foot.

Ascococcus vibrans van Tieghem. (Bul. Soc. Bot. France, 27, 1880, 150.) From water.

Aurococcus tropicus Chalmers and O'Farrell. (1013, quoted from Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1019, 931.) Found in Ceylon in granulating ulcers of skin.

Coccus carduus Heurlin. (Bakt. Unters. d. Keimgehaltes im Genitalkanale d. fiebernden Woohnerinnen Helsingfors, 1010, 136.) Anaerobic. From genital eanal

Coccus caudatus Heurlin (loc. cit., 84).
From genital canal.

Coccus raginalis Heurlin (loc. at., 79). From genital canal.

Galactococcus albus Guillebeau. (Landwirtseb. Jahrb. d. Schweiz, 4, 1892, 27;
Abst. in Cent. f. Bakt., 12, 1892, 101.)
From milk from an inflamed udder.

Galactococcus futrus Guillebeau (loc. cut.). From milk from an inflamed udder Galactococcus versicolor Guillebeau (loc. cit.). From milk from an inflamed udder.

Gyrococcus flaccidifex Glaser and Chapman. (Science, 36, 1912, 219.) Isolated from the gypsy moth, Porthetria disper-Jodococcus taginatus Miller. (Miller,

Prepared for Prof G. J. Hucker by Mrs. Eleanore Heist Clise, New York State Experiment Station, Geneva, New York, March, 1943.

Mikroorganismen der Mundhöhle, 1889, 51; Baclersum 10genum Baumgartner, Ergebnisse d. ges Zahnbeilk , Heft 2, 1910, 729; Abst. in Cent f. Bakt., I Abt, Ref., 48, 1911, 621) From the oral

Merismopedia aurantiaca Maggiora cavity. (Giorn. Soc. Ital. d'Igienc, 11, 1889, 354, Abst. in Cent. ( Bakt , 8, 1890, 13) From the normal skin of the human foot (No. 16. \*

Micrococcus achrous Migula Lemble, Arcb. f. Hyg., 26, 1896, 310, Migula, Syst. d. Bakt, 2, 1900, 201) From feces. Winslow and Winslow (Systematic Relationships of the Coccaceae, 1903, 221) state that this species is apparently a synonym of Micrococcus candi

Micrococcus acidi lactici Marpmain cans Flügge. (Erginzungsheft d Cent f. allg Gesund heitspflege, 2, 1886, 22 ) Found in fresh

Micrococcus acidotoraz Muller-Thur milk. gau and Osterwalder. (Cent f Bakt,

II Abt., \$6, 1913, 236) From wine Hucker (loc. cit., 6) considers this a synonym of Micrococcus Inicus Colin or (Jour

Micrococcus tarians Migula Holland Bact., 5, 1920, 223; Staphylococcus acne Holland, ibid., 225, see Micrococcus cutis

Micrococcus (Staphylococcus) acridi communis Salsourand ) eula Kuffernth. (Ann. de Gembloux, 27, 1921, 253.) Isolated from diseased locusts from Greece. Resembles Micro-

Micrococcus acrius Chester (No 19, соссия ангеня Zopt. Conn, Storrs Agr Exp Sta. 7th Ann Rept., 1805, 81; Chester, Man Determ Bact , 1901, 101 ) From dust (foc. cit , 12) states that this species appears to be identical with Vicrococcus

Micrococcus acrogence Miller (Miller, aureus Zopf. Deutsche med Wehnschr , 12, 1886, 119, not Vicrococcus acrogenes Bergey et al . Manual, 1st ed , 1923, 70 ) From the alimentary canal

Micrococcus agilis albus Catterina. (Cent. f. Bakt., I Abt., Orig., \$4, 1903, 108) Found in septicemia of rabbits

Motile with one or two flagella.

Micrococcus albatus Keru. (Arb bakt. Inst Karlsrube, 1, Heft 4, 1897, 479.) From the intestine of a woodpecker (Picus major). Winslow and Winslow (Systematic Relationships of the Coccaccae, 1908, 199) state that this species appears to be a synonym of Micrococcus albus Schroeter; while Hucker (N. Y. Agr Exper. Sta., Tech. Bull, 102, 19) regards it as a synonym of Micrococcus freudenreichts Guillebeau or Micrococcus urcae Colin.

Micrococcus albescens Henrici. (Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 76 ) From cheese Winslow and Wins. low (foc cit, 199) state that this species appears to be a synonym of Micrococcus afbus Schroeter; while Hucker (loc. ett , 19) regards it as a synonym of Micrococcus freudenreichti Guillebeau or of Ms-(Losski,

crococcus ureae Cohn. Micrococcus albidus Losski Inaug Dies., Dornat, 1893, 55; not Micrococcus albufus Henrici, see Micrococcus subniticus below, not Micrococcus albidus Roze, Compt. rend Acad. Sci. 122, 1896, 750) From soil. Hucker (foc cit , 19) regards this species as a synonym of Microeoccus freudenreichte Guillelieau or Micrococcus ureae Colin

Micrococcus albocereus Migula (Staphylococcus ecreus albus Passet, Untersuch u d Actiol d eiterigen Phlegmone d Menschen, Berlin, 1895, 53, and Fortschr d Med , 3, 1885; Micrococcus cereus afbus Flingge, Die Mikroorganismen, 2 Juff. 1896, 182, Staphylococcus cercus Trevisan, I generi e le specie delle Batterracce, Milan, 1889, 32, Migula, Syst. d Bakt . 2, 1990, 50, Staphylococcus cereus-albus Holland, Jour. Bact , 5, 1929, 225 ) From human pus, also from water Winslow and Winslow (Systematic Relationships of the Coccaccae, 1908, 205) consider this a synonym of Micrococcus

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candidus Cohn or of Gaffhya tetragena Trevisan.

Micrococcus albus Frankland and Frankland. (Phil. Trans. Roy. Soc., London, 178, B, 1888, 264; not Micrococcus albus Matzuschuta, Cent. f. Bakt., I Abt., 29, 1901, 362; not Micrococcus albus Buchanan, Veterinary Baeteriology, 1911, 196; not Micrococcus albus Macé, Traité Pratique de Bact., 6th éd., 1912, 605.) From air. Resembles Micrococcus candicans.

Micrococcus albus II Maggiora. (Cent. f Bakt., 8, 1890, 13.) See Micrococcus opalescens De Toni and Trevisan. From the skin of the human foot.

Micrococcus amplus Migula. (Grauweisser Diplococcus, Bumm, Der Mikrog. d. gonorrh. Schlemhauterkrank., 1 Aufl., 1835, 17; Micrococcus albicans amplus Flugge, Die Mikroorganismen, 2 Aufl., 1886, 183; Nerseria albicans Trevisan, I generi e le specie delle Batteriacee, Milan, 1859, 22; Diplococcus albicans amplus Eissnberg, Bakt. Diag, 3 Aufl., 1891, 24; Migula, Syst. d Bakt., 2,1900, 118; Micrococcus albicans Chester, Man. Determ. Bact., 1901, 80). From vaginal secretions. Hucker (loc cit., 15) considers thus species identical with Micrococcus albus Schrocter

Micrococcus ampullaceus Kern. (Arb. bakt. Inst Karisruhe, I, Ifett 4, 1897, 477.)
From the intestine of a dove (Columba cenas) Hucker (loc cit., 19) considers this a synonym of Micrococcus freudenreichii Guillebeau or Micrococcus ureae Cohn.

Micrococcus annulatus Kern (loc. cit., 490). From the stomach contents of the hedge sparrow (Passer montanus) and the intestine of the rock dove (Columba luvia). Winslow and Winslow (Systematic Relationships of the Coccaca, 1908, 216) consider this species a synonym of Micrococcus flavus Lehmann and Neumann.

Micrococcus aquatilis Bolton. (Zschr. f. Hyg., 1, 1886, 94; not Micrococcus aquatilis Chester, sec below.) From

water. Winslow and Winslow (loc. cit., 221) state that this species is apparently a synonym of Micrococcus candicans Flugge.

Micrococcus aquatilis Chester. (Micrococcus aquatilis invisibilis Yaughan, Amer. Jour. Med. Sci., 104, 1892, 183; Chester, Man. Determ. Bact., 1901, 88.) From water. Winslow and Winslow (loc. ett., 224) state that this species is apparently a synonym of Micrococcus candicans Flinge.

Micrococcus aquatilis albus. (Quoted from Toporoff, Protok. d. Kaiserl, kaukasisch Mediz. Gesellsch., 1892, No. 21; Abst. in Cent. f. Bakt., 18, 1893, 487.) From water.

Micrococcus aquatilis flavus. (Quoted from Toporoff, loc. cit.) From water.

Microeoccus aqueus Migula. (No. 28, Lembke, Arch. f. Hyg., £0, 1896, 317, Migula, Syst. d. Bakt., £, 1909, 201) From feces. Winslow and Winslow (loc. cit., 184) state that this species is apparently a synonym of Micrococcus aureus Zopf, while Hucker (loc. cit., 15) regards this as a synonym of Micrococcus albus Schroeter.

Microeccus arborescens lactis Conn.
(Conn, Storrs Agr. Exp. Sta. 12th Ann
Rept., 1900, 46; Microeccus lacts or
borescens Conn, Esten and Stocking,
Storrs Agr. Exp. Sta. 18th Ann. Repts.
1907, 110.) From milk. Hucker (leccit., 21) regards this as a synonym of
Microeccus candidus Cohn or Microeccus epidermidis Hucker.

Micrococcus argenteus Migula. (No. 27, Lembke, Arch. f. Hyg., 26, 1895, 317) Migula. Syst. d. Bakt., 2, 1909, 205. From feces. Winslow and Winslow (Loc. it., 184) state that this species is apparently a synonym of Micrococcus arress Zopf, while Hucker (Loc. cit., 10) considers it a synonym of Micrococcus confiders it a synonym of Micrococcus confiders it a synonym of Micrococcus Confidence and Migula.

Micrococcus ascoformans Johne. (Zoogloca pulmonis equi Bollinger, Arch. f. path. Anat., 49, 1870, 583; Discomyes equi Rivolta, Giora. di Anat. e Fisiole, 10, 1884; Johne, Bcr. u. d. Veterin. im Kongr. Sachsen, Jahr 1885, 47; Ascococcus johnei Cohn in letter to Johne, Deutsche Ztschr. f. Thiermed , 12, 1886, 210; Micrococcus botryogenus Rabe, Deut Ztschr. f Thiermed , 12, 1886, 137; Botryomuces eaux Bollinger. Deut Ztschr. f. Thiermed., 13, 1887, 176, Botryococcus ascoformans Kitt, Cent f Bakt , 3, 1888, 217, Bollingera equi Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 26, Staphylococcus ascoformans Ford, Textb of Bact , 1927, 424; Staphylococcus aureus var equi Hauduroy et al , Diet d Baet Path , 1937, 504.) Causes botryomycosis in horses. Lehmann and Neumann (Bakt Diag., 7 Aufl , 2, 1927, 291) consider this n form of Micrococcus aureus Zopf, while Hucker (loc cit, 15) regards this as a form of Micrococcus albus Schroeter

Micrococcus ascoformus Fermi. (Arch f. Hyg., 10, 1800, 10.) Presumably intended for Micrococcus ascoformans Johne

Micrococcus asper Migula (Seibert, Inaug. Diss, Wurzburg, 1894, 12, Migula, Syst. d Bakt, 2, 1900, 82) From a hairbrusii Winslow and Winslow (foc. cit, 205) consider this species to be a synonym of Micrococcus candidus Colin or of Gaffku letragena Trevisan

Micrococcus aurantiacus-sorghi Bruyning. (Arch. Néer. Sci. Evact et Nat., 1, 1898, 297; Streptococcus aurantiacus Chester, Man Determ Baet , 1901, 60 ) From sorghum.

Microcecus aureus Chester (Microoccus cromodes aureus Dyar, Ann N Y Acad. Sci. 8, 1895, 349, Chester, Manual Determ. Baet., 1901, 90) From dust. Regarded by Dyar as a varietal form of Microcecus eremidis Zummermann Winslow and Winslow (Loc. ct.), 181) consider this species a synonym of Microcecus aureus Zopf

Micrococcus aureus lactis Conn (Storss Agr. Exp. Sta 12th Ann. Rept , 1909, 36.) From milk. This seems to be identical with Micrococcus lactus aureus A, Conn, Esten and Stocking, Storss Agr. Exper. Sta 18th Ann. Rept., 1907, 119. Hucker (loc. ct., 9) regards this species as identical in part with Micrococcus flavus Lehmann and Neumann and with Micrococcus confloweratus Migula.

Micrococcus (Sareina) baceatus Niguia.
(No 18, Lembke, Arch f Hyg. 26, 1306, 311; Migula, Syst. d. Bakt., 2, 1900, 202.)
From feecs. Winslow and Winslow (loc. ct., 232) state that this is a yellow, gelatin-liquelying sareina, apparently a synonym of Sareina flata De Bary. Hucker (loc ct., 10) considers this a synonym of Micrococcus conglomeratus Migula.

Micrococcus badius Lehmann and Neumann (Bakt Diag , 1 Aufl., 2, 1896, 163) Received from the Kral collection as Sarcina lutea Winslow and Winslow (loc cit, 218) consider this a synonym of Micrococcus flavus Lehmann and Neu-

Micrococcus baregensis purpureus Robinc and Hauduroy. (Compt. rend Soc. Biol, Paris, 08, 1928, 25.) From hot sulfur springs at Barèges.

Microoccus bergélii (Rabenhorst) Migula (Pleurococcus bergélii Kuchenmester and Rabenhorst, Ikchiga, 1867, No 4, Scleratum bergélianum Hallier, 1868, Zoogloca bergéliana Eberth, 1873; Hyalooccus bergélii Schroeter, Kryptog.-Flora v Schlesien, 3, 1, 1886, 152; Chamyadamus bergélii Tervasan, Rendiconti Reale Inst Lombardo de Sei, e Lett, Ser. II, 12, 1879, 22; Migula, Syst. d Bakt., 2, 1900, 193; Trichosporum bergélii Vuillemin, 1901) From human hair.

Micrococcus beri-bers Pekelharing. (Pekelharing, Weekblad v. h. Ned. Tijdschr v. Geneesk., No 25; also Pekelharing and Winkler, Deut med. Wehnschr, No 39, 1887, 845; Netsseria veinkler: Trevisan, I generi o le specie delle Batterrace, Milan, 1889, 32.) Considered the cause of beri-beri by Pekelharing Winslow and Winslow (Ioc. cit., 181) state that this is apparently a synonym of Nicrococcus aureus Zonf; while Illucker (Ioc. cit., 11) considers

this a synonym of Micrococcus citreus Migula.

Micrococcus bicolor Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1897, 485.) From the intestine of a dove (Columba cenas). Hucker (loc. cit., 21) considers this a synonym of Micrococcus candidus Cohn or of Micrococcus epidetmidis Hucker.

Micrococcus billrathii (Cohn) Migula. (Ascocccus billrathii Cohn, Beitr. z. Biol. d Pflanzen, 1, Heft 3, 1875, 151; Migula, Syst. d. Bakt., 2, 1900, 195.) Found in putrefying meat infusion.

Micrococcus biskra Heydenreich. (Heydenreich, Ausgabe d. Haupt Med.-Verhalt., St. Petersburg, 1888; see Cent. f. Bakt., 5, 1889, 163; Staphylococcus biskrae Trevisan, I genere ele specie delle Batteriacee, Milan, 1889, 32; Micrococcus heydenreichis Chester, Man. Determ. Bact, 1901, 91) Found in ulcres in an Oriental skin disease. Winslow and Winslow (loc. cit., 181) state that this is apparently a synonym of Micrococcus arreus Zopf, while Hucker (loc. cit., 11) considers it a synonym of Micrococcus citreus Misula.

Micrococcus bolet: Passecini. (Erbar. crittogam. Italiano, II sor, No. 1109; quoted from Trevisan, I generi e le specie delle Batteriacec, Milan, 1889, 34) Saprophytic on a Iuogus (Boletus edulis).

Micrococcus bombycis (Naegeli) Cohn. (Panhistophyton ovatum Lebert, Jahresber ü. d. Wirksamkeit d Vereins z. Beförd, d. Seidenbaues f. Brandenburg im Jahre 1856-57, 28; and Berhner Entomolog Ztschr., 1858; Nosema bombycis Naegeli, Botan. Seet. d. 33 Versammlg d. Naturf. u. Aerzte in Bonn, 1857, 160; and Botan Zeitg., 1857, 760; Microzyma bombyers Béchamp, Compt. rend Acad. Sci., Paris, 64, 1867, 1015; Cohn, Beitr. z. Biol. d. Pflanzen, 1, Heft 2, 1872, 165; Micrococcus oratus Winter, in Rabenhorst, Krypt. Flora v. Deutschl., Oesterr. u. d. Sehweiz, 2 Aufl , 1, 1884, 47; Streptococcus bombycis Zopf, Die Spaltpilze, 2 Aufl., 1881, 52.) Found in the blood and organs of diseased silkworms (Bombyz mori).

Micrococcus boreus Issatchenko. (Reeberches sur les Microbes de l'Ocean Glacial Arctique, Petrograd, 1914, 141.) From sea water.

Micrococcus bovinus Migula. (Micrococcus der Lungenseuche der Rinder, Poels and Nolen, Fortschr. d. Med, 1886, 217; Migula, Syst. d. Bakt., \$, 1900, 67?) From the lungs of diseased cattle. Hueker (loc. cit., 22) regards this a synonym of Micrococcus candidut Cohn or of Micrococcus epidermidis Ilucker.

Micrococcus bovis Migula. (Hematococcus, Babes, Compt. rend. Acad. Sci., Paris, 107, 1883, 692 and 110, 1899, 809 and 975; also see Arch. f. path. Anat, 115, 1889; Neisseria babesi Trovisas, 12 generi e le specio delle Battoriace, Milan, 1889, 32; Haematococcus boru Eisenberg, Bakt. Diag., 3 Aufl., 1891, 271; Migula, Syst. d. Bakt., 2, 1003, 155 From the blood and organs of cattle.

Micrococcus burchardti Trevisa. (Coccus bei keratitis phlyetaenuloss. Burehardt, Cent. f. Bakt., f. 1837, 392; Trevisan, I generi e le specie delle Batternece, Milan, 1889, 33.) Pathogenic From the cornea of a rabbit.

Micrococcus butyri (v. Klecki) Migula (Diplococcus butyri von Klecki, Cent I. Bakt., 16, 1891, 358; Migula, Syst. d. Bakt., 2, 1900, 216.) From rancid butter. Winslow and Winslow (loc. cit., 220) consider this a synonym of Micrococcus luteus Cohn.

Micrococcus butyri fluorescens Teichert (Inaug. Diss., Jena, 1904; Abst. in Cent f. Bakt., II Abt., 13, 1904, 561.) From milk. Exhibits a green fluorescence.

Micrococcus bulyricus (von Klecki)
Migula. (Tetracoccus bulyricus van
Klecki, Cent. f. Bakt., 15, 1831, 301,
Migula, Syst. d. Bakt., 2, 1900, 216)
From rancid butter. Winslow and Winalow (loc. cil., 220) consider this a syoonym of Micrococcus luteus Cohn.

Micrococcus calco-aceticus Beijerinek. (Proc. Sect. Sci., Kon. Akad. v. Wetenschappen, 13, 1911, 1066; Abst. in Cent f. Bakt., II Abt., 51, 1912, 290.) Occurs commonly in soils.

Micrococcus campeneus Orme. (Jour. Trop Med. and Hyg., 11, 1908, No 10, May 15; Abst. in Cent. f Bakt, I Abt,

Ref , 45, 1909, 299.)

Micrococcus candicans Flugge (Die Mikroorganismen, 2 Aufl, 1886, 173, Albococcus candicans Winslow and Rogers, Jour. Inf. Dis, 3, 1906, 544, Staphylococcus candicans Holland, Jour Bact, 6, 1920, 225.) From air, water and milk. Hucker (be et., 22) regards this a synonym of Micrococcus candidus Cohin or of Micrococcus epidermidis Hucker. For a description of this species, see Bergey et al., Manual, 5th ed., 1930, 255

Micrococcus canaccans Migula (Micrococcus No. 4, Adamet., Landwitzsch Jahrb., 18, 1889, 240; Migula, Syst d Bakt., 2, 1000, 51; Albococcus canescens Winslow and Rogers, Jour Inf Dis., 3, 1903, 544; Sizphylococcus canescens Holland, Jour. Bact., 6, 1920, 225) From Emmenthal cheese. Winslow and Winslow (Ioc. cit., 224) state that this is apparently a synonym of Micrococcus candicans Flugge.

Micrococcu capillorum (Buhl) Trevisan. (Zoogloca capillorum Buhl, Ztschr. f. ration. Mod., II Reihe, 44, 18-35; Palmella capillorum Kuhn, Abhandl d. Naturf Ges zu Ifalle, 9, Heft 1, 18-62, Palmellina capillorum Rabenhorst, Flor. Eur. Alg., 3, 1856 (?), 35, Trevisan, I generi e Ie specie delle Batteriacce, Milan, 1859, 33) From the skin Considered pathogenic.

Micrococcus capsaformans Jamieson and Edington. (Brit. Med. Jour. 1, June 11, 1887, 1262; Micrococcus caproforms (sio), Abst in Cent. f. Bakt., 2, 1887, 223.) From the scales and blood of soarlet fever patients Not pathogenic

Micrococcus carbo Renault. (Compt rend. Acad. Sei., Paris, 123, 1896, 935) Micrococcus carneus Zimmermann. (Roter Coccus, Masebek. Bakt. Untersuch d. Leitmeritz. Trink assers, No. 5, 1887, 60; Zimmermann, Die Bakt. unserer Trink u. Nutzwisser, Chennitz, I Reihe, 1890, 78.) From water. Hucker (loc. cit., 25 and 20) regards this species as identical with Micrococcus rossus Flugge or Micrococcus cinnabareus Flugze.

Micrococcus connector Frankland and Frankland. (Phil. Trans. Roy. Soc. London, 173, B, 1888, 293, not Micrococus caraicolor Kern, see Micrococcus subcarneus below.) From air. Hucker (loc cit, 25) states that this species may be identical with Micrococcus roseus Flüger.

Micrococcus carniphilus Wilhelmy. (Arb bakt. Inst. Karlsruhe, 5, 1903, 10.)

From a meat extract.

Micrococcus cassi amari edamicus
Raamot. (Inaug. Diss., Königsberg, 1006;
Abst. in Cent. f. Bakt., II Abt., 18.

1007, 315) From pasteurised skim milk, Micrococcus castellanii Chalmers and O'Farrell. (Ann Trop. Med. and Parastol, 7, 1913, 523; Rhodococcus castellanii Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 2102.) Found in the red variety of trichomycosis axillaris, a tropoted disease.

Micrococcus cartharinensis Issatchenko. (Recherches sur les Microbes de l'Oceán Glacial Artique, Petrograd, 1914, 143.) From sea water.

Micrococcus cellaris (Schroeter) Migula (Leucocystis cellaris Schroeter, Kryptog Flora v. Schlesien, 5, 1886, 152; Migula, Syst d. Bakt, 2, 1900, 195.) From a coating on the walls of damp cellars and mines

Micrococcus centropunciatus Issatchenko. (Recherches sur les Microbes de l'Oceda Glacial Arctique, Petrograd, 1914, 146.) From sea water.

Micrococcus cerasinus Migula (Mierococcus aus roter Milch, Keferstein; Cent. f. Bakt., I Abt., 21, 1897, 177; Micrococcus cerasinus lactis Heim, Lehrb. d. Bakt, 2 Aufl., 1898, 299; Migula, Syst d. Bakt, 2, 1900, 170; not Micrococcus cerasirus Lehmann and Neumann, Bakt. Diag, 1 Aufl, 2, 1896, 179; Micrococcus kefersteinni Chester, Man. Determ. Bact., 1901, 197.) From red milk. Hucker (loc cit., 20) regards this species as identical with Micrococcus cinnabureus Filares.

Micrococcus cereus Migula. (Staphylococcus cereus flavus Passet, Untersuchungen über die Actiologie der eiterigen Phlegmone des Menschen, 1885, 53; Micrococcus cereus flavus Flugge, Die Mikroorganismen, 2 Aufl., 1886, 182; Staphylococcus passet: Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 32; Migula, Syst. d. Bakt., 2, 1900. 126; Staphylococcus cereus flavus Holland, Jour. Bact., 5, 1920, 225 ) From pus. Winslow and Winslow (loc. cit, 220) consider this species identical with Micrococcus luteus Migula. For a description of this organism, see Bergey et al., Manual, 5th ed., 1939, 241.

Micrococcus cereus aureus Dyar. (Ann. N. Y. Acad. Sci., 8, 1895, 347.) Obtained as Staphylococcus cereus aureus from Kral's laboratory; also found in air.

Micrococcus cerinus Henrici. (Arb. bakt. Inst Karlsruhe, 1, Heft 1, 1894, 84.) From Swiss cheese. Winslow and Winslow (loc. cit., 216) consider this a synonym of Micrococcus flavus Trevisan.

Micrococcus chersonesia Corbet.
(Quart. Jour. Rubber Research Inst.,
Malaya, 2, 1930, 150.) From the latex
of the rubber tree (Hevea brasiliensis).
For a description of this species, see
Bergey et al., Manual, 5th ed., 1939,
258.

Micrococcus chinicus Emmerling and Abderhalden. (Cent. f. Bakt., II Abt., 10, 1902, 337) Putrefying meat.

Micrococcus chlorimus Cohn. (Grungelber Coccus, Maschek, Jahresber. d. Kom. Oberrealschule zu Leitmeritz, 1887, 66; Cohn, Beitr. z Diol d. Pflanzen, 1, Heft 2, 1872, 155 ) From water and dust. Hucker (loc. at., 10) considers

this a synonym of Micrococcus conglomeratus Migula.

Micrococcus chromidrogenus citreu Trommsdorff. (Munch. Med. Wochnschr., 1901, No. 29, 1286; Abst. in Cent. f. Bakt., I Abt., Ref., 37, 1905, 60) Isolated from a case of chromidrosis of the axilla.

Micrococcus chromidrogenus ruber Trommsdorff (loc, cri.). Isolated from a case of chromidrosis of the axilla

Micrococcus chromoflavus Huss. (Cent. f. Bakt., II Abt., 19, 1907, 520) From cheese

Micrococcus chryscus Frankland and Frankland. (Phil. Trans. Roy. Soc. London, 178, B, 1888, 268.) From dust. Winslow and Winslow (loc. cit., 184) state that this species is apparently a synonym of Micrococcus aureus Zoof.

Micrococcus cinnabarius Zinmermann. (Die Bakt. unserer Trink. u. Nutzwasser, Chomnitz, I Reihe, 180, 76.) From water. Hucker (loc. cit., 26) regards this species as identical with Micrococcus cinnabaraus Flugge.

Micrococcus cirrhiformis Migula (Ranken Coccus, Maschek, Jahresber d. Kom.- Oberrealschule in Leitmentt, 1887, 66; Migula, Syst. d. Bakt, \$, 190, 53) From water, Hucker (loc. at, 200, 200 considers this a synonym of Micrococcus candidus Cohn or of Micrococcus epidermids Hucker.

Micrococcus citreus I and II, Maggiors (Giora, Soc. Ital, d'Igiene, II, 1889, 354, Abst. in Cent. f. Bakt., 8, 1890, 13, not Micrococcus citreus Eisenberg, Bakt Diag, 3 Aufl., 1891, 36, not Micrococcus citreus Migula, Syst. d. Bakt., 2, 1900, 417; not Micrococcus citreus Winslow and Winslow, Systematic Relationships of the Coccaceae, 1908, 218.) From the normal skin of the foot.

Micrococcus citreus granulatus Freund. (Inaug. Diss., Erlangen, 1893, 27; Abst. in Cent. f. Bakt., 16, 1894, 641, Micrococcus granulatus Bazarewski, Cent f Bakt., II Abt., 15, 1905, 7; not Micrococcus granulatus Weiss, Arb. bakt. Inst. Karlsruhe, 2, Heit 3, 1902, 197.) From the oral cavity. Hucker (loc. cit., 9) regards this as a synonym of Micrococcus flavus Trevisan.

Micrococcus citreus lactis Conn. (Storrs Agr. Exp. Sta 12th Ann. Rept., 1900, 40.) From milk. Hucker (loc. cit., 10) considers this a synonym of Micrococcus conglomeratus Migula.

Micrococcus citreus rigensis Bazartwski. (Cent. f. Bakt., II Abt., 15, 1905, 5.) From dust.

Micrococcus citrinus Migula. (Diplococcus citreus liquidaciens Unna and Tommasoli, Monats. f. prakt Dermadologic, 9, 1889, 66; Migula, Syst. d. Bakt. 2, 1900, 150; Micrococcus formasoli Chester, Man. Determ. Bact., 1901, 101; Micrococcus citreus liquidaciens Winslow and Winslow, Systematic Relationships of the Coccaccae, 1908, 216) From human skin in a case of eezema. Winslow and Winslow (dec. cit., 216) consider this a synonym of Micrococcus flavus Trevison.

Micrococcus claviformis von Besser. (Beitr. z. path. Anat. u z. aligem. Path., 6, 1889, 340; see Cent. f. Bakt., 7, 1890, 152.) Yound once in nasal scretions

Micrococcus coccineus Mgula. (Micrococcus No. VI, Adamotz, Landwirtsch. Jahrb., 18, 1889, 212; Migula, Syst. d. Bakt. 2, 1900, 174.) From Emmenthal cheese. Hucker (loc. cit., 20) regards this species identical with Micrococcus cinnabareus Florce.

Micrococcus cols brens Lehmann. (Lehmann, Inaug. Diss, München, 1903; Abst. in Cent f. Bakt., I Abt., Ref., 30, 1905, 688.) From feces of infants.

Micrococcus communis lactis Conn. (Starts Agr. Lep Sta. 12th Ann. Rept., 1900, 48.) From milk. Hucker (loc cit, 19) considers this a synonym of Micrococcus freudenreichn Guillebeau or of Micrococcus ureae Cohn.

Micrococcus commensalis (Turro) Migula (Diplococcus commensalis Turro, Cent. f. Bakt., 16, 1891, 1; Migula, Syst. d. Bakt., 2, 1900, 125.) From sputum. Winslow and Winslow (loc. cit., 220) consider this a synonym of Micrococcus luteus Cohn.

Micrococcus commutatus De Toni and Trevisan. (Micrococcus albus I or Micrococcus albus fluidicans Maggiora, Giorn Soc. Ital. d'Igiene, 11, 1889, 350; De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1079.)

Micrococcus concentrates Zimmermann. (Die Bakt. unserer Trink- u. Nutzwässer, Chemants, I Reihe, 1809, 86.) From water, Winslow and Winslow (loc. ett., 221) state that this is apparently a synonym of Micrococcus condicans Flugge.

Micrococcus confuens Kern. (Arb. bat. Inst Karlsrube, I, Heft 4, 1897, 491) From the stomach and intestine of the starling (Sturnus vulgaris) and the flach (Fringella cardutals). Winslow and Winslow (loc. ett., 216) consider this a synonym of Micrococcus florus Trevisan.

Microceccus conjunctinac Migula. (Microceccus injurfacients conjunctivac Gombert, Recherches evpérimentales sur les microbes des conjunctives, Montpelher and Pans, 1859; Migula, Syst. d. Bakt, 2, 1000, 115) From normal haman conjunctiva. Hucker (loc et., 15) considers this a synonym of Microceccus albus Schroder.

Micrococcus conjunctivata Migula.

(Micrococcus faunt conjunctione Gombert, Recherches expérimentales sur les microbes des conjunctives, Montpellier and Paris, 1839), Migula, Syst. d. Bak, 2, 1900, 141). From normal human conjunctiva. Winelow and Winslow (Icc. ett., 219) consider this a synonym of Vicrococcus faunt Trevian, while Hucher (Icc. ett., 11) regards it as a synonym of Micrococcus circus Migula synonym of Micrococcus circus Migula.

Micrococcus conoideus Migula. (Staphylococcus salicarius pyogenes Blondi. Zischr i Hyg., 2, 1887, 227, Staphylococcus sualopyus Trevisan, I generi e le specie delle Batteriacce, Milan, 1882, 32; Micrococcus salivarius pyogenes Froire, Mēmoire sur la hactériologie, pathogénie, traitement et prophylaxie de la fievre jaune. Rio de Janiero, 1898; Abst. in Cent. f. Bakt., I Abt., 26, 1899, 741; Slaphylococcus pyogenes salivarius, quoted from Goadby, Trans. of Odontolog. Society, June, 1899, see Abst. in Cent. f. Bakt., I Abt., Ret., 31, 1902, 493, Migula, Syst. d Bakt., 2, 1900, 102.) From saliva Hucker (doc. cit., 12 and 15) regards this as a synonym of Micrococcus ourcus Zopi or of Micrococcus olbus Schrootter.

Micrococcus coralinus Cantani. (Cantani, Cent. f. Bakt., I Abt., 25, 1893, 311; Rhodococcus corolinus (sic) Levine and Soppeland, Iowa State Coll. Engineering Esp Sta Bul. 77, 1926, 22.) From dust. Hucher (loc. cit., 25) considers this a synonym of Micrococcus roseus Flügge. Levine and Soppeland (loc. cit.) regard this as a synonym of Rhodococcus fulrus Winslow and Rogers. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 253.

Micrococcus coralloides Zimmermann. (Die Bakt unserer Trink- u. Nutzwässer, Chemnitz, II Reiho, 1891, 72) From water. Winslow and Winslow (loc. cit., 190) state that this species appears to be a synonym of Micrococcus albus Zopf; while Hucker (loc. cit., 17) considers it a synonym of Micrococcus cascolyteus Evans.

Micrococcus corrugatus Migula. (Alerismopedia mesentericus corrugatus Dyar, Ann. N. Y. Aesd. Sci., 8, 1895, 355; Migula, Syst. d. Bakt., 2, 1900, 161.) From dust Winslow and Winslow (loc. cit., 216) consider thus a synonym of Micrococcus flavus Trovisan.

Mitrococcus coryace (Hajok) Migula. Opplococcus coryace Hajok, Berliner klin. Wochnschr., No. 33, 1888, Migula, Syst. d. Bakt., 2, 1900, 63.) From secretions in acute catarth. Winslow and Winslow (loc ett., 205) consider this a synonym of Micrococcus candidus Cohn or of Gaffkya tetragena Trevisan.

Micrococcus cremoides Zimmermann (Die Bakt. unserer Trink-u. Nutzwasser, Chemnitz, I Reihe, 1890, 74.) From water. Winslow and Winslow (loc. cit. 216) consider this a synonym of Micrococcus flarus Trevisan; while Hucker (loc. cit., 10) considers it a synonym of Micrococcus considers at a synonym of Micrococcus considers and Singula.

Micrococcus cremoides albus Dyar. (Ann. N. Y. Acad. Sci., 8, 1895, 359). From dust. Regarded by Dyar as a white form of Micrococcus cremoides Timmermann.

Micrococcus cremorisviscosi (Hammer and Cordes) Bergey et al. (Staphylococcus cremoris-viscosi Hammer and Cordes, Jour. Dairy Sci. 5, 1020, 201; Bergey et al., Manual, 3rd ed., 1930, 88.) From ropy milk. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 251.

Micrococcus crepusculum (Ehrenberg)
Colin. (Alonas crepusculum Ehrenberg,
Abhandl. d. Berliner Alad., 1830, 74 and
1832, 57; Colin, Bettr. z. Biol. d. Pflanzen,
1, Heft 2, 1872, 160). De Toni and Trevisan (in Saccardo, Sylloge Fungorum, 8,
1859, 1082) list the following as synonyms
of this species; Protococcus nebulosus
Kutzing, Linneae, 8, 1833, 365; Cryptococcus nebulosus Kutzing, Phycol. genet.,
1845, 147, Cryptococcus natans Kutzing,
Spec. Alg., 1849, 146.

Micrococcus crelaceus Henrici. (Arb bakt. Inst Karlsruho, I, Heft I, 1994, 65) From cheese. Winslow and Winslow (loc. cit., 224) state that this is spparently a symonym of Micrococcus candicans Flugge.

Micrococcus cristatus Glage. (Ztschr. f. Fleisch- u. Milch-hygiene, 10, 1900, 145.) From the surface of wurst and similar meat products.

Micrococcus cruciformis Freire. (Compt. rend. Acad. Sci., Paris, 128, 1899, 1047.) From the stamens and pistils of Hibiscus.

Micrococcus cumulatus Kern. (Arbbakt. Inst. Karlsruhe, 1, Heft 4, 1897, 497; not Micrococcus cumulatus Chester, see Micrococcus tenuissimus Migula.) From the stomach and intestine of the yellow-hammer (Embersia citizella) and of the finel. (Fringella carducis). Blucker (loc. cit., 25) regards this as a synonym of Micrococcus roseus Flugge

Micrococcus cupularis Migula (No 29, Lemble, Arch. I Hyg., 29, 1807, 331, Migula, Syst. d Bakt., 2, 1900, 21) From feces Winslow and Winslow (loc ett., 216) consider this a synonym of Micrococcus flavus Trevisan

Micrococus cupuliformis Migula. (No 19, Lemble, Arch f Hyg, 29, 1897, 325, Migula, Syst. d. Bakt, 2, 1900, 213) From feces. Winslow and Winslow (locatila, 220) consider this a synonym of

Micrococcus luteus Cohn
Micrococcus curtus: Chorne (Chorine, Internat. Corn Borer Invest. Chucago, 2, 1929, 18) From discased larvae
of the corn borer (Pyravata nubitalis)
Also virulent to larvae of the flour moth
(Ephestia Kahnella) and of the bee moth

(Galleria mellonella)

Micrococcu cuits communs Sabourand. (Sabourand, Ann. d. dermado et ayphil, 1806, Heft 3; Alst in Cent f Bakt, I Abt, 20, 1896, 219; Staphylococcus cuits communis Sabourand, Practique Dermadologique, 1, 1903, 714.) From human shin expecially in alopeea nareata, certaut types of exerna and aene. May be the same as Migrococcus endremulst Hucker.

Micrococcus ejaneux (Schroeter) Cohn (Bacteridium ejaneum Schroeter, Beitz 2, Bol. d., Pilanzen, f., Heft 2, 1872, 122 and 126; Cohn, ibid., 156, Nigrococcus ejaneus Castellini and Chalmers, Mrn Trop. Med. 2 and ed., 1919, 932.) From

dust and water

Micrococcus epanopenus Pammel and Combs (Proc Iowa Acad Sci. 3, 1895, 136; see Abst in Cent f Bikt, H Abt, 2, 1896, 761) From nulk

Micrococcus cyclops Henrici (Arb. 1akt. Inst. Karlsruhe, 1, Heft 1, 1891, 69.) From Swiss cheese Window and Window (Ioc. ct., 224) state that this is

apparently a synonym of Micrococcus candicans Flügge.

Micrococcus cystiopoeus Muller-Thur gau. (Cent f. Bakt., 11 Abt., 20, 1908 461.) From wine.

Hierococcus cytophagus Merker. (Cent f. Bakt., H Abt., \$1, 1912, 589.) Found on the leaves of Llodca. Utilizes cellulose Stanier (Bact. Rev., \$6, 1912 150) thinks that these micrococcu were mucrocysts of Sproceylophagus app

Micrococcus danteni Chester. (Coccus du rouge de monue, Le Dantec, Ann. Past. Inst., 5, 1801, 662; Chester, Man. Determ. Bact., 1901, 100 ) From red salted codifish. Hucker (loc. cit., 25) considers this a synonym of Micrococcus roseus Flogree.

Micrococcus decalvens (Thin) Schrocter. (Bacterium decaltens Thin, Monats f prakt. Dermatol., No. 29, 1885; Schrocter in Cohn, Kryptog.-l'Iora v. Schlesien, 5, 1, 1886, 149.) Trom hair follieles in alopecia areata.

Micrococcus decipient Trevisan. (Bactérie de l'air, Cornil and Babes, Les Buctéries, 1885, 124; Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 36) From dust.

Micrococcus (Strepleoccus ?) decolor Migula (Xo. 22, Lemble, Arch. f. Hyg., 20, 1890, 311; Migula, Syst. d. Bakt, 2, 1900, 203.) From feces. Hucker (Lo. cit, 17) considers this a synonym of Micrococcus cascolyticus Lyans

Micrococcus deformans Crowe. (Brit. Med. Jant., Nov. 27, 1929, 815; Abst. in Cent. f. Bakt., I Abt., Ref., 78, 1922, 81). From cases of arthritis. A form of Micrococcus pyogenes albus according to Lehmann and Neutrann (Bakt. Ding., 7 Audl. 8, 1927, 293).

Micrococcus delacourianus Bore. (Compt. rend. Acad. Sci., Paris, 123, 1896, 613 and 1323) From dry rotting potators.

Micrococcus dendroporthus Ludwig. (Cent. f. Bakt., 10, 1891, 10.) From the bark of popular trees (Populus sp.). Micrococcus denitrificans Beijerinek. (Cent. f. Bakt., II Abt., 25, 1910, 53.) From Rochelle salts (sodium potassium tartrate).

Micrococcus dermatogenes Fuhrmann. (Cent. f Bakt., II Abt., 17, 1906, 618.) \* From bottled beer.

Micrococcus diffuens Schroeter. (In Cohn, Kryptog.-Flora v. Schlesien, 8, 1, 1886, 144.) From dust, feees, etc.

Microcaccus dimorphies Bucherer. (Planta, Arch f wissen, Bot., 1931, 98.) A dimorphic bacterium. He reports it as much like Microcaccus mellitensis Bruce and Bacterium fraenkelii Hashimoto.

Micrococcus diphterieus (sic) Colin (Micrococcus, Octel), Deutschi. Arch f. klin Med , 8, 1871; Colin, Beitr, z. Biol. d Pflanzen, 1, Heft 2, 1872, 162; Streptococcus diphtheriticus Zopf, Die Spatie pilze, 3 Auf. 1835, 53 ) From throats and nasal passages of diphtheria patients

Mterococcus dissimilis Dyar. (Sea Sattler, Cent f. Hakt. 5, 1889, 70; Dyar, Ann N Y. Acad Sci., 8, 1895, 333; Microoccus trachomatis conjunctivae Sattler in Kral, Die gegennartigen Bestand der Kral'seihen Sammlung von Mikroorganismen, 1900, 19) From trachoma infections. Hucker (loc ett., 17) considers thisa synonym of Micrococcus cascolyticus Evans.

Micrococcus djokjakariensis Zettnow. (Cent. f. Bakt., I Abt., Orig , 75, 1915, 376.) From a sugar factory in Java.

Micrococcus doyen: De Toni and Trevisan. (Micrococcus urinae albus olearius Doyen, Jour. d connaiss. médic., No. 14, 1889, 108, De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1076.) From urine Hucker (loc. cit., 16) states that this species is apparently identical with Micrococcus albus Schroeter.

Micrococcus drimophylus Baumgartner. (Baumgartner, Ergebmisse d ges Zahnheilk., Heft 2, 1910, 729, Abst in Cent f. Bakt., I Abt., Ref., 48, 1911, 622.) From the mouth cavity Micrococcus catonii Corbet. (Quart. Jubber Research Inst. Malaya, 2, 1930, 145.) From the latex of the rubber tree (IIceca brasiliensis). For a description of this species, see Berger et nl., Manual, 5th ed., 1939, 244.

Micrococcus churneus Henrici. (Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1891, 85.) From Camembert cheese. Winslow and Winslow (loc. cit., 221) state that this species is apparently a synonym of Micrococcus candicans Flugge.

Micrococcus ephestiae Mattes. (Sitzungsber. d. Gesellsch. z. Beförd. d. gesamt. Naturwissensch. zu Marburg. 62, 1927, 406.) From the Mediterranean flour moth (Ephestia kuchnicila).

Micrococcus epimetheus Corbet (loc. cit., 145). From the later of the rubber tree (Herea brasilienss). For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 256.

Micrococcus esterificans Beck. (Arb. kaiser! Gesundheitsamte, 29, 11eft 2, 1905, Abst. in Cent. f. Bakt., II Abr., 19, 1907, 591.) Has a claracteristic fruity from Trom butter.

Microsoccus , exanthematicus Lewascheff. (Deutsch. med. Wochnschr., No-13 and 34, 1892; Abst. in Cent. I. Bakt. 12, 1892, 635.) From blood in cases of typhus fever. Motile. Grows anaerobically.

Micrococcus excaratus Kern. (Arb. bakt. Inst. Karlsruhe, I, Heft 4, 1874, 1865.) From the stomach contents of a coot (Fulica otra) and a woodpecker (Pieus major). Winslow and Winslow (Ioc. cit, 220) consider this a synonym of Micrococcus luteus Cohn.

Micrococcus exiguus Kern (loc. cil, 470) From the stomach contents of the chaffinch (Fringella coclebs). Winslow and Winslow (loc. cit, 199) state that this oppears to be a synonym of Micrococcus albus Schroeter; while Hucker (loc. cit, 19) considers it a synonym of Micrococcus greadenreichii Guillebeau or of Micrococcus ureae Cohn.

Micrococcus expositionis Chester. (No

34, Conn, Storrs Agr. Exp Sta 7th Ann Rept., 1805, 77; Chester, Man Determ Bact, 1801, 92) From air Winslow and Winslow (loc. cit. 216) consider this a synonym of Micrococcus fawar Trevisan; while Hucker (loc cit, 10) regards it as a synonym of Micrococcus conglomeratus Migula.

Micrococcus expressus Weiss. (Arb bakt, Inst. Karlsruhe, 2, Heft 3, 1902, 195.) From a carrot infusion. Produces slime, Hucker (loc. ett, 7) considers this species a synonym of Micrococcus luteus Cohn or of Micrococcus sarians Micula.

virigitite.

Micrococcus faujormus Migula (Milchweisser Diplococcus, Bumm, Mi-krong. d. genorth. Schleimbauthr, 11 Ausg., 1887, 18; Micrococcus lactus faujormis Finge, Die Mikrorgannsmen, 2 Aufl., 1880, 182; Neisseria lactea Trevisan, I genori ele specie delle Batteriacee, Milan, 1880, 32; Migula, 593, 874 d Bakt, \$, 1900, 117.) From vagital and other body secretions. Winslow and Winslow (icc. cit., 199) state that this appears to be a synonym of Micrococcus albus Schrotter.

Micrococcus fedde: Herter. (Micrococcus XVI, Choukevitch, Ann Inst Past., 25, 1911, 354; Botan. Jahresber, 35, II Abr., Heft 4, 1914, 755; Abst. in Cent. f. Bakt., II Abr., 5f, 1920, 367) From the large intestine of a borse. Resembles Micrococcus resender Mateu-

schita.

Micrococcus fervilosus Adametz and Wichmann (Bakt. d. Trink- u Nutzwässer, Mitt. Oest. Versuchstat f. Brauerei u. Mälierei, Wien, Heft 1, 1888) Fram water Winslow and Winslow (loc. cit., 205) consider thus a synonym of Gaffkya letragena Trevisan.

Micrococcus fichit Trevisan. (Coccus albus non liquefaciens (Coccus candicons) Fick, Ueber Microorg. in Conjunctivalsack, Wiesbaden, 1887; Trovisan, I generi e le specie delle Batteriacee, Milan, 1889, 33.) From conjunctiva

Micrococcus finlayensis Sternberg (Rept. on Etiology and Prevention of Yellow Fever, Washington, 1801, 219.) Obtained by Finlay in cultures from the liver and spleen of a yellow-fever cadaver. Hucker (loc. cit, 11) considers this a synonym of Micrococcus citreus Migula.

Micrococcus flaccidifes danai Brown (Amer Museum Novit., No. 251, 1927, 5) Causative agent of wilt disease of monarch butterfly larvae (Danais archippus) Considered a sub-species of Gyrococcus flaccidifes Glaser and Chapman (Science, 39, 1912, 219).

Micrococcus flagellatus Klotz (Jour. Med Research, 11 (NS6), 1904, 493.) Found in an epizoetic among rabbits and white rats Supposedly flagellated.

Micrococcus flavens Henriei. (Arb bakt Inst Karlsruhe, 1, Heft 1, 1894, 80) From Swiss cheese Winslow and Winslow (loc. ett., 216) consider this a synonym of Micrococcus flavus Trevisan

Micrococcus flassecens Henric (Arb. bakt Inst Karlsrube, I, Hoft 1, 1894, 79) From Swiss choose Winslow and Winslow (foe ett., 200) consider this a synonym of Micrococcus flasses Trovisan. For a description of this species, see Bergey et al., Manual, 5th ed., 1839, 246.

Microenceus Javidus Henriel (Inc. ett. 81; not Micrococcus Javidus Rozer, Compt. rend Acad Sci., Inris, 122, 1896, 750) From Suiss and Limburger cheeses. Winslow and Winslow (Inc. ett., 216) consider this a synonym of Micrococcus Javus Trevisan.

Micrococcus flavovirens Migula. (Staphylococcus viridis flavescens Guttmann, Arch I. path. Anat., 107, 1887, 201, Staphylococcus viridisflavescens Trevism, I. generi e les pecie delle Batteriacce, Milan, 1880, 33; Migula, Syst. d. Bakt., 2, 1000, 121; Micrococcus viridisflavescens Winslow and Winslow, Systematic Relationships of the Gocaccue, 1900, 221.) Winslow and Winslow (Mud., 200) consider this a synonym of Micrococcus letter Schn.

Micrococcus flavus non liquefaciens

Amsler. (Amsler, Korrespondenbl. f. Schweizer Aerzte, 1900, No. 9; Abst. in Cent. f. Bakt, I Abt., 29, 1901, 450.) From thermal springs.

Micrococcus fluorescens Maggiora. (Giorn Soc. Ital. d'Igiene, 11, 1839, 352; Abst. in Cent. f. Bakt., 8, 1890, 13.) From the skin of the foot.

Micrococcus foctidus Flugge. (Die Mikroorganismen, 2 Aufl., 1886, 172; not Micrococcus foctidus Veillon, Compt. rend. Soc Biol. Paris, 1893, 867; see Streptococcus foctidus Prévot.) From carious tect.

Micrococcus foetidus Klamann. (Allgem. med. Centralizeitung, 1857, 1341.) Isolated from the posterior nares of man. Winslow and Winslow (loc. cit., 199) state that this appears to be a synonym of Micrococcus albus Schreeter.

Micrococcus fragilis (Dyar) Migula. (Merismopedia fragilis Dyar, Ann. N. Y. Acad Sci., 8, 1895, 351; Migula, Syst. d. Bakt., 2, 1900, 186) From dust. Hucker (Oc. cit., 25) states that this species may be identical with Micrococcus roseus Fluzze.

Micrococcus franklandiorum Trevisan. (Micrococcus candicans Frankland and Frankland, Phil Trans. Roy. Soc. London, 178, B, 1888, 270; not Micrococcus candicans Flugge, Die Mikrootganismon, 2 Aufl, 1886, 173; Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 34.) From dust.

Micrococcus fulvus Weiss. (Arb. a bakt. Inst Karlsruhe, 2, Heft 3, 1902, 206; not Micrococcus fulvus Cohn, Beitr z. biol d Pflanz, 1, Heft 3, 1875, 181.) From a bean infusion.

Micrococcus fuscus Adametz. (Brunner Coccus, Maschek, Jahresh, d Kommunal-Oberrealsch zu Leitmentz, No. 6, 1867, 60; Adametz, Bakt. d. Nutz-u. Trinkwässer, Vienna, 1888, Micrococcus fuscus Castellani and Chalmers, Man Tropended, 3rd ed., 1919, 932) Hueker (Ioccit., 10) states that this species is probably identical with Micrococcus conglomeratus Migula

Micrococcus galbanalus Zimmermana. (Bakt. unserer Trink- u. Nutrudsser, Chemnitz, II Reihe, 1894, 68.) From water. Winslow and Winslow (loc. cit, 216) consider this a synonym of Micrococcus flavus Trevisan.

Micrococcus gallicidus Burrill. (Amer. Nat., 17, 1883, 320.) From blood of fowls infected with chicken cholcra.

Micrococcus gclatinogenus Bräutigam. (Pharmaceutische Centralhalle, 32, 1891, 427.) From digitalis infusions See Micrococcus gummosus Happ.

Micrococcus gelatinosus Warrington. (The Lancet, 1, 1888, No. 25; Abst. in Cent. f. Bakt., 4, 1888, 394.) Curdles milk

Micrococcus gelatinosus Issatchenho. Recherches sur les Microbes de l'Océan Glacial Arctique, Petrograd, 1914, 222; not Micrococcus gelatinosus Warringtos, The Lancet, 1, 1888, No. 25.) From scawater.

Micrococcus giganteus lactis Conn (Storrs Agr. Exp. Sta. 12th Ann. Rept, 1900, 46.) From milk.

Micrococcus giges Frankland and Frankland. (Philos. Trans, Roy. Soc., London, 178, B, 1888, 268.) From dust Winslow and Winslow (loc. cit., 216) consider this a synonym of Micrococcus fagus Trevisan.

Micrococcus gilvus Losski. (Inaug. Diss., Dorpat, 1893, 60.) Winslow and Winslow (loc. cit., 220) consider this a synonym of Micrococcus luteus Cohn.

Micrococcus gingivae Migula. (Micrococcus gingivae pyogenes Miller, Die Mikroorganismen d. Mindhöhle, Leipzig, 1889, 216; Migula, Syst. d. Bakt. 2, 1900, 63.) From alveolar pyorrhoea, also from the mouth of a healthy man.

Micrococcus gingreardi Renault (Compt. rend. Acad. Sci., Paris, 120, 1895, 217.)

Micrococcus glandulosus Weiss. (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 201.) From an asparagus infusion. Hucker (loc. cit., 19) regards this species as identical with Micrococcus freudenreichii Guillebeau or with Micrococcus ureae

Cohn.

Micrococcus globous Kern (Arb. bakt. Inst. Karlsruhe, J. Heit 4, 1897, 469.) From the stomach contents of a coot (Fulica atra). Winslow and Winstow (Loc. et.), 224) state that this is apparently a synonym of Micrococcus candicans Fluxco.

Micrococcus granulatus Weiss. (Arb bakt. Inst. Karlsruhe, 2, Heft 3, 1902,

197.) From a malt infusion

Micrococcus granvlosus Kern (loc. cit, 183). From the stomach contents of the yellon-hammer (Embersia citrinella) and the starling (Sturnus vulgaris) Winstow and Winstow (loc. cit., 200) consider this a synonym of Micrococcus Inteus Cohn.

Micrococcus griseus (Warming) Winter (Bacterium griseum Warming, Videnskabelige Meddololser fra den naturhist Forening i Kjobenhavn, 1875, 393, Winter, in Rabenhorst, Kryptog -Flora v. Doutschl., Ocaterr u d Schweiz. 2

Aufl., 1, 1884, 47)

Micrococcus grossus Henrica (Arb hakt. Inst. Karlsruhe, 1, Heft 1, 1894, 71.) From Camembert cheese Winslow and Winslow (loc cit, 221) state that this is apparently a synonym of Micrococcus candicans Fluwe

Micrococcus gummosus Happ (Happ, Inaug, Diss., Basel, 1893, 31, not Microoccus gummosus Weiss, Arb bakt Inst Karlsruhe, 2, Heft 3, 1902, 189) From snakeroot and digitalis infusions Presumably Leuconostoc mescnteroides Van

Tieghem.

Micrococcus haematodes Zopf. (Micrococcus haematodes Zopf. Biol Centralbl., 2, 1882, No. 8; Zopf. Die Spaltpilze, 3 Aufl., 1885, 60.) The cause of red perspiration Hucker (loc. ctt., 25) states that this may be a synonym of Micrococcus roseus Fluxes.

Micrococcus haemorrhagicus (Klein) Migula. (Staphylococcus haemorrhagicus Klein, Cont. f. Bakt., I Abt., 22, 1837, 81; Migula, Syst. d. Bakt., 2, 1909, 88.) Associated with an crythema of the skin resembling anthrax. Winslow and Winstow (toc. cit., 190) state that this appears to be a synonym of Micrococcus albus Schroeter.

Micrococcus halensis Lehmann and Neumann. (Micrococcus acidi poralactici liqui facient halensis Kozal, Zitakr.

I. Hyg. 51, 1899, 374; Lehmann and Neumann, Bakt. Diag., 2 Aufl., 9, 1899, 210, Micrococcus acidi paralactici liquifaciens Thiele, Zitakn. f. Hyg., 48, 1904, 394.) From milk. Hucker (loc. cit., 17) considers this a synonym of Micrococcus acaselulius Evans.

Micrococcus halophilus Bergey et al. (Culture No. 19, Barmink-Pikowsky, Cent. f Bakt., II Abt., 70, 1927, 373; Bergey et al., Manual, 3rd ed., 1939, 89 From sea water For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 253.

Micrococcus hauseri (Rosenthal) Migula (Diplococcus hauseri Rosenthal, Inaug Diss., Berlin, 1893, 20; Migula, loc ett., 80) From the oral eavity. Winslow and Winslow (loc. cit., 224) sate that this species is apparently identical with Micrococcus candicant Fluges.

Mucrooccus helvolus Henrici (Arbbakt Inst. Karlsruhe, 1, Heft 1, 1804, 77) From Swiss cheese. Winslow and Winslow (loe ett., 220) consider this to be identical with Micrococcus luteus Cohn

Micrococcus hibiscus Nalahama (Jour-Agr Chem. Soc. Japan, 18, 1940, 315, Eng Abs, Bull Agr. Chem Soc., 16, 1940, 51) Isolated from retting kenaf, (Hibiscus).

Microeccus humidus Migula. (Micrococus No. 2, Adametz, Landwirtsch. Jahrb, 18, 1889, 239; Migula, Syst. d Bakt, 2, 1900, 50.) From Emmenthal cheese. Winslow and Winslow (loc. ett., 221) state that this species is apparently identical with Microeccus candicons Flugge. Migula.

188; not Micrococcus minimus Bergey et al., Manual, 1st ed., 1923, 69.) Trom a bean infusion. Hucker (loc. cit., 7) considers this a synonym of either Micrococcus lutius Cohn or Micrococcus lutius Cohn or Micrococcus lutius

Micrococcus minutissimus Issatchenko. (Recherches sur les Microbes de l'Océan Glacial Artique, Petrograd, 1914, 146.) From sea water.

Micrococcus mirificus (Rabenhorst) Trevisan. (Palmella mirifica Rabenhorst, Hedwigia, 1867, 115, and Ffor. Europ. Algar., 5, 1856, 35; Trevisan, Rendie R. Ist Lombardo, 12, 1879.)

Micrococcus mollis (Dyar) Migula. (Merismopedia mollis Dyar, Ann. N. Y. Acad. Sci, 8, 1893, 332; Migula, Syst. d. Bakt., 2, 1900, 161; Aurococcus mollis Winslow and Rogers, Science, 21, 1905, 600; Stophylococcus mollis Holland, Jour. Bact., 5, 1920, 225.) From air. A cause of boils in the tropics, according to Castellani and Chalmers (Man. Trop. Med., 3rd ed., 1910, 031) Hucker (Ioc. cit., 12) states that this species is apparently identical with Micrococcus aureus Zopf. Micrococcus (Diplococcus) morthuae Klebahn (Mitteil Inst Allgm. Botan.

Hamburg, 4, 1919, 11-69; Abst. in Cent f. Bakt, 11 Abt, 52, 1921, 123.) Halophilic Associated with spoilage of salted fish.

Micrococcus mucilagineus Weiss.

Micrococcus mucilogineus Weiss.
(Arb. bakt. Inst. Karlsruhe, 2, Hieft 3,
1002, 191.) From bean infusions.
Hucker (loc. cit., 11) states that this is
probably a synonym of Micrococcus
citreus Misula

Micrococcus mucliaginosus Migula. (Micrococcus der schleimigen Milch, Ratz, Arch. f Tierheitkunde, 12, Heft 1 and 2, 1890; Migula, Syst. d. Bakt., 2, 1900, 119; not Micrococcus mucliaginosus Weiss, Arb bakt Inst. Karlsrule, 2, Heft 3, 1902, 205.) From slimy milk. Winslow and Winslow (do. cit, 199) state that this appears to be a synonym of Micrococcus albus Schroeter; while Huecker (loc. cit, 18) considers it a syn-

onym in part of Micrococcus caseolyticus Evans.

Micrococcus mucofaciens Thôni and Thaysen. (Cent. f. Bakt., 11 Abt., 35, 1913, 359; not Micrococcus mucofaciens Pribram, Klassifikation der Schizomyceten, 1933, 42.) From milk. Hucher (loc. cit., 9) considers this a synonym of Micrococcus flavus Trevisan. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 245.

Micrococcus myceticus Castellani. (Proe. Soc. Exp. Biol. and Med., 25, 1928, 535-536.) From gummy lesions Micrococcus mycodermatus Holland.

(Jour. Baet., 5, 1920, 224.)

Micrococcus nocreaceus Migula. (Perlmutterglānzender Diplococcus, Tataroff, Irauug. Diss., Dorpat, 1891, 70; Migula, Syst. d. Bakt., 2, 1900, 62.) Winslow and Winslow (Ioc. cit., 224) state that this is apparently a synonym of Micrococcus candicans Flugge.

Micrococcus ncoformons Doyen. (Doyen, Le Micrococcus ncoformons et les neoplasmes, Paris, 1903.) From cancerous tissue. Shown by Andrewes and Gordon (35th Ann. Rept. Local Govt Doard, London, 1905-06, 553) to be identical with Micrococcus epidermidis albus Welch.

Micrococcus neurotomae Paillot. (Compt. rend. Aead. Sei., Paris, 178, 1924, 246.) Gram-negative. From the larvae of Neurotoma nemoralis.

Micrococcus neuvillei Trevisan. (Micrococcus G, Malapert-Neuville, 187; Trevisan, I generi e le specie delle Batteriaece, Milan, 1889, 34.) From mineral water.

Micrococcus nigrescens Castellani. (Brit. Jour. of Dermatology, 25, 1911, 341; Nigrococcus nigrescens Castellani and Chalmers, Man. Trop. Med., 3rd ed, 1919, 2103.) Produces a black pigment-Found in the black variety of trichomycosis avillaris, a tropical disease.

Micrococcus nigrofaciens Northrup. (Mich. Agr. Exp Sta. Tech. Bull. No 18, 1914, 12; also in Cent. f. Bakt., II Abt., 41, 1914, 326.) From diseased larvae of the June beetle (Lachnosterna \*p.) and other insects.

Micrococcus nitidus Kern. (Arb bakt. Inst. Karlsrube, 1, Heft 4, 1897, 476 )
From the stomach and intestine of birds Winslow and Winslow (Ice. cit., 199) state that this appears to be a synonym of Micrococcus albus Schroeter, while Hucker (Ice. cit., 19) regards it as a synonym of Micrococcus freudenreichts Guilebeau or of Micrococcus greudenreichts Guilebeau or of Micrococcus greudenreichts Guilebeau or of Micrococcus greudenreichts Guilebeau or of Micrococcus greudenreichts

Micrococcus nitrificans Bergey et al (Micrococcus, 6, Rubentscheck, Cent f Bakt., II Abt., 72, 1927, 125, Bergey et al, Manual, 3rd ed., 1930, 88, not Micrococcus nitrificans van Tieghem, Traité de Botanique, Paris, 1883.) From sewage filter bed. For a description of this species, see Bergey et al., Manual, 5th ed. 1930, 257.

Micrococcus nivalis Chester. (No 47,

Conn, Storrs Agr. Lyp. Sta. 7th Ann Rept., 1895, 89, Chester, Man Determ Bact, 1901, 90.) From dust. Winslow and Winslow (loc. cit., 224) state that this is apparently a synonym of Microoccus candicans Flüger.

Micrococcus nurcus Henne (Arb hakt. Inst. Karlsruhe, 1, Heft 1, 1891, 66.) From Swiss cheese. Winslow and Winslow (los. cit., 221) state that this is apparently a synonym of Micrococcus condicans Flügge.

Micrococcus nonfermentans Steinhaus (Jour. Bact., 42, 1911, 779.) From the alimentary tract of the lyreman escada (Tibicen linnei) and of an unidentified damsel fly (Coenogripmidae)

Micrococcus nublist Migula (Coccus B, Poutin, Bakt Untersuch, von Hagel, Wratsch, No. 49 and 50, 1889, see Cent. I. Bakt, 7, 1800, 373, Migula, Syst d Bakt, 2, 1900, 01; Micrococcus beta Chester, Man. Determ Bact, 1901, 87.) Isolated from hail. Wratelow and Wissłow (loc. cit., 205) consider this to be a synonym of Micrococcus candidus Colm or of Gofflys titrogram Trevism.

Micrococcus nuclei Roze (Compt

rend. Acad. Sci., Paris, 122, 1896, 544.) From potatoes.

Micrococcus obscornus Kern (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1897, 473.) From the stomach contents of a crow (Corrus corone). Winslow and Winslow (Icc. cit., 199) state that this appears to be a synonym of Micrococcus abus Schroeter; while Hucker (Icc. cit., 190) considers it a synonym of Micrococcus freudenteichi: Guillebeau or of Micrococcus ureae Cohn

Micrococcus ochraceus Rosenthal. (Inaug. Diss., Erlangen, 1803, 22; Abst. in
Cent f. Bakt., 16, 1801, 1621; not Micrococcus ochraceus Hanagung, Oestr. Bot.
Ztschr., 1855, No. 4) From the ornl
cavity Winslow and Wunslow (loc. cit.,
20) consider this a synonym of Micrococcus Intens Migula. For a description
of this species ace Bergey et al., Manual,
5th ed., 1909, 212.

Micrococcusochroleucus Prove. (Prove, Beitr z Biol d Pfilanz 4, Hotta 3, 1887, 409, Streptococcus ochroleucus Trevisan, I genera e lo specio delle Batteriaces, Milan, 1889, 31, Planococcus ochroleucus Migula, Syst d Bakt, 2, 1909, 272 ) From urine. Motile

Micrococcus odoratus Henrici. (Arb. laht Inst Karlsruhe, 1, Heft 1, 1891, 73) From Cheese Winslow and Winslow (loc cit, 221) state that this is apparently a synonym of Micrococcus candicans Fliege.

Merococcus odorus Henrici (loc cit., 72) From cheese Winslow and Winslow (loc cit., 221) state that this species is apparently a synonym of Micrococcus candicans Flüere

Metrococcus oleanus DeTon and Trevisan (Micrococcus urinae flarus oleanus Dyen, Jour d'contants Midre-No 14, 1889, 108, DeToni and Trevisan, in Secardo, 8) floge funorum, 8, 1889, 1672.) From urine Hucker (loc cit., 12) considers this species a synonym of Micrococcus aureus Zopl

Micrococcus olens Henrier (Arli. linkt Inst. Karlsrube, 1, Heft 1, 1891, 87.) From Swiss cheese. Winslow and Winslow (loc. cit., 216) consider this a synonym of Micrococcus flavus Trevisan.

Micrococcus opalescens DeToni and Trevisan. (Micrococcus albus II, Maggiora, Giora. Soc. Ital. d'Igiene, 11, 1839, 351; DeToni and Trevisan, in Saccardo, Sylloge Fungorum. 8, 1889, 1078.)

Micrococcus orbicularis Chester. (Micrococcus orbicularis flavus Favenel, Mem. Nat. Acal. Sci., 6, 1896, 8; Chester, Man Determ. Bact., 1901, 101.) From soil Winslow and Winslow (foc. cit, 216) consider this a synonym of Micrococcus flavus Trevisan; while Ilucker (foc. cit, 10) regards it as a synonym of Micrococcus condomeratus Migula.

Micrococcus orbiculatus Wright. (Mem. Nat. Acad Sci., 7, 1895, 432.) From Schuyllill River water. Winslow and Winslow (loc cit, 220) consider this a synonym of Micrococcus Intens Cohn.

a synonym of Micrococcus Indeus Cohn.
Micrococcus vails Kern. (Arb. bakt.
Inst. Karlsruhe, I, Heft 4, 1897, 500;
not Micrococcus oralis Escherich, Die
Darmbakterien des Sauglings, Stuttgart,
1885, 90) From the stomach contents
of the rock dove (Columba Inva).
Hucker (loc. ctt, 0) regards this as a
synonym of Micrococcus fauss Trevisan.

Micrococcus pallens Henrici. (Arb. bakt Inst. Karlsruhe, 1, Heft 1, 1894, 61.) From cheese. Winslow and Winslow (loc cit, 205) consider this a synonym of Micrococcus candidus Colin or of Gafkya tetragona Trevisan.

Micrococcus pallidus Henrici (loc cit., 62) From cheese Hucker (loc. cit., 7) regards this species as identical with either Micrococcus luteus Cohn or Micrococcus varians Migula.

Micrococcus pannosus Kern. (Arb. bakt. Inst. Karlsrubc, 1, Heft 4, 1897, 466.) From the stomach contents of the rock dove (Columba luria) and the intestine of another dove (Columba cenas). Winslow and Winslow (loc cit., 221) state that this is apparently a synonym of Micrococcus candicans Flügze.

Micrococcus parafinae Söhngen.

(Cent. f. Bakt., II Abt , 57, 1913, 595.) From garden earth.

Micrococcus parotitidis Korentschensky. (Cent. f. Bakt., I Abt., Orig, 44, 1907, 402.) Isolated from cases of parotitis epidemica.

Micrococcus pareus (Miller) Trevisan (Jodococcus pareus Miller, Deutsche med. Wehnschr., No. 30, 1883; Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 33)

Micrococcus parsus Migula. (No 14, Lembke, Arch. f. Hyg., 28, 1896, 309; Migula, Syst. d. Bakt., 2, 1909, 200) From feces. Winslow and Winslow (loc cit., 224) state that this species is apparently a synonym of Micrococcus candicans Flugge.

Microeccus pasteuri Trevisan. (Mierobe pyogene de l'eau de Seine, Pasteur, 1877; Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 34; not Micrococcus pasteuri Sternberg, Trans. Pathol Soc. of Philadelphia, 12, 1885, 162.) From water.

Micrococcus pellucidus Kern. (Atb. bakt. Inst. Karlsrube, 1, Helt 4, 1837, 468; not Micrococcus pellucidus Rote, Compt. rend. Acad. Sci., Paris, 122, 1896, 1012.) From the intestine of a sparrow (Passer montanus). Hucher (for.cti., 23) regards this as a synonym of Micrococcus candidus Cohn or of Micrococcus candidus Hucker.

Micrococcus pemphigi Migula. (Diplococcus des Pemphigus acutus, Denme, Verhandl. d. Kongr. f. innere Med. Wiesbaden, 1886, 336; Diplococcus pemphigi oculi Lehmann and Neumann, Bakt. Ding., I Auß., 2, 1806, 173; Migula, Syst d Bakt., 2, 1900, V and 101; Micrococcus denmes Chester, Man Detern. Bact., 1901, 73.) Isolated from bulas in a case of pemphigus acutus.

Micrococcus pemphigicontagiosi Casteliani and Chalmers. (Micrococcus pemphigi contoposa Clega and Wherry, Jour-Int. Dis., 3, 1906, 171; Castellani and Chalmers, Man. Trop. Med., 3rd ed, 1919, 931.) From bullae in a caso of pemphigus contagiosa. This may be a synonym of Micrococcus pemphigineonatorum, see below.

Micrococcus pemphajuncondorum Castellani and Chalmers. (Micrococcus pemphaji neonatorum Almquist, Zisehr I. Ilyr., 10, 1991, 233, Staphylicoccus pemphaji neonatorum Lehmana nani Neu manu, Bakt. Drug., 1 Aufl., 2, 1896, 173, Castellani and Chalmers, Mun. Trup Med., 3rd ed., 1919, 971.) Found in bulkes in a case of pemphagua neonatorum This may be Micrococcus moltis, according to Castellani and Chalmers (the cit.) Talls (dour. Inf. Des., 29, 1917, 57) identifies this and the previous organism as Micrococcus proponer. yar aureus Zopf.

Micrococcus' percitens Bergey et al (Manual, 1st ed., 1923, 63) From au and water. Hueker (loc est., 10) considers this a synonym of Micrococcus conflomeratus Migula. Tor a description of this species, see Bergey et al., Minual, 5th ed., 1939, 218.

Micrococcus perilarus Bergey et al (Manual, 1st ed., 1923, 62) I'mm arr and water. Hucker (loc. cit, 12) regards this as a synonym of Micrococcus aureus Zopf. For a description of this species, see Bergey et al, Manual, 5th ed., 1939, 247.

Micrococcus persicus Kern (Arb bakt. Inst. Karlsruhe, 7, Heft 1, 1897, 199) From the intestine of a dove (Columba acnas). Hucker (loc cit, 25) states that this may be identical with Micrococcus roscus Fluxee.

Micrococcus petechialis Trovisan (Mierococco del dermotifo, Bareggi, 1886, Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 33)

Micrococcus petilus Trevisin. (Micrococcus der Pyaemio bei Kaninchen, Koch, Über d. Actiolog. d. Wundunfectionskr., Leipzig, 1878; Micrococcus pyaemiae cuniculorum Schrocter, in Cohn, Kryptogam. Flora v. Schlesien, 5, 1, 1880, 148, Trevisan, I genere i el specie delle Batteriacee, Milan, 1889, 33; Micrococcus cuniculorum Migula, Syst. d. Bakt., 2, 1900, 192) From rabbits.

Micrococcus petrolei Remault. (Compt.

ioted from Ciattenden, U. S. Dept. Agr., Farmers' Bull No 1161, 1920, 6) From larvae of the cabbage butterfly (Pieris rapac).

Micrococcus pilouskyi Bergey et al., Cuature No. 22, Baranik-Pikowaky, Cent. l. Bakt. II Abt., 70, 1927, 373; Bergey et al., Manual, 3rd od., 1930, 78.) From sea water. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 212.

Micrococcus piliformis Weias. (Arb. bakt Inst. Karlsrule, 2, Heft 3, 1902, 191) From a ben infusion. Hucker (foc ett., 7) considers this a synonym of Micrococcus luteus Cohn or of Micrococcus sureuran Migula

Micrococcus piltonensis Gray and Thornton. (Cent f Bakt, II Abt, 73, 1923, 81) From manuro and soil For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 250

Microcecus pitutoperus (Hohl) Buchann and Hammer. (Korphocecus)
(Carphocecus) pitutoperus Hohl, Jahrb.
d Schweis, 22, 1006, 439, Diplocecus
suscesus Sato, Cent. I. Bakt, 11 Abt.,
19, 1907, 27; Buchanan and Hammer,
fowa Agtr. Ftp. Sta. Res. Bull 22, 1915,
285) From elimy milk and from straw.
Hueker (loc cit., 23) states that this
species is probably identical with Micrococcus candidus Colin or with Microcecus
spuderandis Hueker. For a description
of this species, see Borgoy et al , Manual,
5th ed. 1939, 213

Micrococcus plumosus Eisenberg. (Brautigam, Inaug. Diss.), Lepzig, 1886, 185, Federiger Micrococcus, Adametz, Mitteil. d Ocsterr Versuchssta I. Braucrei u Mikterel, Wice, Ilelt I, 1885; Eisenberg, Bakt. Diag. 3 Aufl, 1801, 56.) From leces of cattle and from water. Winslow and Winslow (Go. ctf.)

220) consider this a synonym of Micrococcus luteus Cohn; while Hucker (loc. cit., 22 and 23) regards it as probably identical with Micrococcus candidus Colin or Micrococcus epidermidis Hucker.

Micrococcus polypus Migula. Bakt , 2, 1900, 79.) From air. Hucker (loc. cit., 23) states that this species is probably identical with Micrococcus candidus Colin or Micrococcus epidermidis Hucker.

Micrococcus populi Delacroix. (Bul. Mens. Off. Renseig Agr., Paris, 5, 1906, 1349 and Ann. Inst. Nat. Agron., 2 Ser., 5, 1906, 353.) Parasitic on poplar trees (Populus spp ).

Micrococcus

porcellorum Trevisan. (Micrococcus bei Hepatitis enzoctica porcellorum, Nonewitsch, Cent. f. Bakt., 3, 1888, 233, Trevisan, I generi e le specio delle Batteriacce, Milan, 1889, 33 ) From nn infected liver.

progrediens Schroeter Micrococcus (Micrococcus der progressiven Abscessbildung ber Kaninchen, Koch, Über d Actiolog. d. Wundinfectionskrankheiten, Leipzig, 1878; Schroeter, in Cohn, Kryptogam Flora v. Schlesien, 3, 1, 1896, 148; Micrococcus haematosaprus Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 33.) From the blood of diseased rabbits.

Micrococcus psalteri Buemann (Cent f. Bakt , I Abt., Orig , 71, 1913, 308 ) From the third stomach of cattle

Micrococcus pseudocyancus Schroeter. (Kryptogam · Flora v. Schlesien, 5, 1, 1886, 145 ) A synonym of Micrococcus cyaneus Cohn according to Migula, Syst.

d. Bakt., 2, 1900, 188.

Micrococcus pseudoinfluenzae Migula. (Microorganismus I, Fischel, Ztschr. f Heilkunde, 12, 1891; See Cent. f. Bakt., g, 1891, 611; Migula, Syst d. Bakt , £, 1900, 86 ) From the blood of an influenza patient. Hucker (los cit., 23) considers this a synonym of Micrococcus candidus Cohn or of Micrococcus epidermidis Hucker

Microcaccua pulcher Glage (Ztschr  Fleisch- u. Milchhyg., 10, 1900, 146; not Micrococcus pulcher Weiss, Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 182) From coating on surface of wurst and similar meat products.

Micrococcus pultiformis Kern. (Arb bakt. Inst. Karlsruhe, 1, Heft 4, 1897, 474.) From stomach contents of the yellow-hammer (Emberiza citrinella) and starling (Sturnus vulgaris) and from the intestine of the woodpecker (Picus major). Winslow and Winslow (loc. cil, 199) state that this appears to be a syaonym of Micrococcus albus Schroeter; while Hucker (loc. cit., 19) regards it as probably identical with Micrococcus freudenreichii Guillebeau or with Micrococcus ureac Cohn.

Micrococcus punctatus Migula. (No. 18, Lembke, Arch. f. Hyg., 29, 1897, 325, Migula, Syst. d. Bakt., 2, 1900, 213) From feecs. Winslow and Winslow (loc cit., 199) state that this species appears to be a synonym of Micrococcus albus

Sehroeter

Micrococcus purpurifaciens Lehmann (Micrococcus, Dudtand Neumann schenko, Cent. f. Bakt., II Abt., 42, 1915, 529; Lehmann and Neumann, Bakt Ding , 6 Aufl., 2, 1920, 755.) From ice Produces n purple pigment in aikaline gelatin media. Henneberg.

pustulatus Micrococcus (Cent. f. Bakt., II Abt., 55, 1922, 251.) From the human intestine.

putridus Micrococcus

Tilanus (Munch med. Wchnschr., 34, 1887, 310) From gelatin, agar, etc., containing iodiform. Micrococcus pygmacus Henneberg (lee

cit., 252) From the human intestine. pyocyaneus Francisco Micrococcus (Revista Valenciana de Ciencias Médicas, 1914, 2, Abst in Cent. f. Bakt., I Abt, Ref., 65, 1915, 44; not Micrococcus pyocyaneus Gessard, Thesis, Paris, 1882) From an acne pustule.

Micrococcus pyosepticus (Héricourtand Richet) Solowjew (Staphylococcus pyosepticus Héricourt and Richet, Compt

rend. Acad. Sci., Paris, 107, 1883, 691; Solowiew, Abst. in Cent. f. Bakt. I Abt., 18, 1895, 60.) I'rom an abscess in a dog and from dust. Regarded as identical with Micrococcus albus Schroeter

Micrococcus quadrigeminus Klebs. (Staphylococcus quadrigeminus Vanselow and Czaplewski, Cent. f. Bakt., I Abt . 25, 1890, 113; see Lehmann and Neumann. Bakt. Dung., 2 Aufl., 2, 1899, 174) Closely related to Micrococcus olbus Schroeter.

Micrococcus augiernus Migula (Sicbert, Inaug. Diss. Würzburg, No. I. 1891. 7. Migula, Syst. d. Bakt., 2, 1900. 92 ) Winslow and Winslow (for cit. 190) state that this appears to be a synonym of Micrococcus ofbus Schroeter.

Micrococcus radiotus l'lugge. (Die Mikroorganismen, 2 Aufl., 1886, 176; Streptmuccus radiotus Crookshank, Man of Bact., 3rd ed , 1890, 256; not Mierococcus radiatus Kern, see below ) From dust and water. Winslow and Wenston (loc. cit., 199) state that this appears to be a synonym of Micrococcus albus Schroeter; while Hucker floe, est , 13) considers it a synonym of Micrococcus careolyticus Evans.

Micrococcus radiatus Kern, (Kern, Arb. bakt. Inst. Karlsruhe, 1, Ileft 4, 1807, 471; Micrococcus radiosus Migula, Syst. d. Bakt., 2, 1900, 114 ) From the stomach contents of the starling (Sturnus vulgaris). Winslow and Winslow (loc cit, 199) state that this appears to be a synonym of Micrococcus albus Schroeter

Micrococcus Tecss11 Rosenthal (Inaug. Diss., Berlin, 1893, 19; Abst. in Cent f. Bakt., 16, 1891, 1021.) From the oral cavity. Winslow and Winslow (loc. cit , 199) state that this appears to be a synonym of Micrococcus afbus Schroeter.

Micrococcus regularis Weiss. bakt Inst Karlsruhe, 2, Heft 3, 1902, 183.) From bean infusions. Hucker (loc cil, 7) considers this a synonym of Micrococcus luteus Cohn'or Microcoecus varians Mıgula.

Micrococcus resinaceus Kern, (Arb. balt, Inst. Karlsrube, 1, Heft 4, 1897. 487.) From the stomach contents of the starling (Sturnus rulgaris) and from the intestine of a sparrow (Passer montanus). Winslow and Winslow (loc. cit., 220) regard this as a synonym of Micrococcus Intens Cohn

Micrococcus rhenanus Migula. (Neuer Mikromecus aus Rheinwasser, Burri, Arch. I. Hyg., 19, 1893, 31; Migula, Syst. d. Bakt., 2, 1900, 109; Micrococcus rheni Chester, Man. Determ. Bact., 1901, 82; Albecoccus rhenonus Winslow and Rogers. Jour. Inf. Dis., 5, 1906, 511.) 1'rons Rhae River water. Wintlow and Winslon (loc cit., 199) state that this appears to be a synonym of Micrococcus albus Schroeter; while Hucker (loc. cit., 18) considers It a synonym of Micrococcus coscolutious Evans.

Hierococcus ridleyi Corbet, (Quart. Jour. Rubber Research Inst., Malaya, 2. 1930, 146.) From the later of the rubber tree (Herca brasiliensis). For a description of this species, see Bergey et al , Manual, 5th ed., 1939, 211.

Micrococcus rosoceus Frankland and Frankland, (Trans. Rey Bociety. London, 178, B. 188, 269; Rhodococcus rosaceus Holland, Jour. Bact , 5, 1920, 225) From air Hucker (los cit., 25) states that this species may be identical with Micrococcus roseus Flügge. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 252

Micrococcus rosoceus lactis Conn. (Storrs Agr. Exp. Sta 12th Ann Rept., 1900, 31; Micrococcus lactis resaccus Conn, Laten and Stocking, Storrs Agr. Exp Sta. Rept. for 1906, 108.) From milk.

Micrococcus rescidus Migula. (Micrococcus No I, Adametz, Landwirtsch. Jahrb., 18, 1889, 238; Migula, Syst. d. Bakt . 2, 1900, 68 ) From Emmenthal cheese. Winslow and Winslow (loc. cit.. 224) state that this is apparently a synonymof Microccccus candicans Flügge.

Micrococcus roseo-persicinus Migula.

(Rote Kokken von Van Ermengem, Schneider, Arb. bakt. Inst. Karlsruhe, 1, Heft 2, 1894, 216; Migula, Syst. d. Bakt., 2, 1900, 184)

Micrococcus rosetlaceus Zimmermann.
(Bakt. unserer Trink- u. Nutzwasser,
Chemnitz, I Reihe, 1899, 72.) From
water. Winslow and Winslow (loc. cit.,
224) state that this is apparently a
synonym of Micrococcus candicans
Flugge,

Micrococcus roseus Maggiora (Giorn. Soc. Ital. d'Igiene, 11, 1889, 356; not Micrococcus roseus Fluggo, Die Mikrorganismen, 2 Aufl., 1886, 183; not Micrococcus roseus Gruber, Cent. f. Bakt., II Abt., 22, 1909, 403)

Micrococcus rubellus Migula. (Syst. d. Bakt., 2, 1900, 169) Source not given. Hucker (loc. cit., 27) regards this as identical with Micrococcus cinnabareus

Flugge.

Micrococcus rubescens Migula. (No. 20, Lembke, Arch. f Hyg, 26, 1896, 312; Migula, Syst d Bakt, 2, 1900, 208; not Micrococcus rubescens Chester, see Micrococcus subroscus below) From feees. Hucker (loc cit., 27) regards this species as identical with Micrococcus cinnabareus Flugge.

Micrococcus rubidus lacits Conn (Conn, Storrs Agr Exp Sta 12th Ann. Rept., 1900, 34, Micrococcus tacits rubidus Conn, Esten and Stocking, Storrs Agr. Exp Sta 18th Ann Rept., 1907, 117.) From milk. Resembles Micrococcus enmabareus Flugge Hucker (loc. cut., 25) thinks this species may be identical with Micrococcus roseus Flugge.

Micrococcus rubigenosus Kern. (Arb. bakt. Inst. Knrlsruhe, 1, Heft 4, 1897, 492.) From the stomach contents of a dove (Columba ocnas). Hucker (Ioc. cut., 25) states that this species may be identical with Micrococcus roscus Flugge.

Microcolcus rubiginosus Passer. and Beltr. (Furg Sicil., 18—, no 35, quoted from De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1082)

Micrococc rus rugatus Migula (Micro-

coccus endocarditidis rugatus Weichselbaum, Beitr. z. path. Anat. u. z. allgm. Pathol., 4, 1889, 164; Migula, Syst. d Bakt., 2, 1900, 190; Micrococcus endocarditus Chester, Man. Determ. Bart, 1901, 74.) From ulcerative endocardits. Winslow and Winslow (loc. cit., 205) consider this a synonym of Micrococcus candidus Cohn or of Gaffkya tetragena Trevisan; while Hucker (loc. cit., 15) regards it as a synonym of Micrococcus albus Schroeter.

Micrococcus rugosus Chester. (No. 2, Conn., Storrs Agr. Exp. Sta. 6th Ann Rept., 1894, 50; Chester, Man. Determ. Bact., 1901, 101.) From milk and ripened cream. Winslow and Winslow (loc. cit., 216) consider this a synonym of Micrococcus flavus Trovisan.

Micrococcus ruminantium Henneberg. (Cent. f. Bakt., II Abt., 55, 1922, 252) From the human intestine.

Micrococcus rushmorei Bronn. (Amer. Museum Novit., No. 251, 1927, 4.) Isolated from a fly (Lucilia sericata) which was infected with Bacillus lutrae.

Micrococcus saccatus Migula. (Micrococcus albus liquefaciens von Besset, Beitr. z. path. Anat., 6, 1889, 46; Micrococcus liquefaciens albus, sec Cent. 1. Bakt , 7, 1890, 152; Migula, Syst. d Bakt., 2, 1900, 117; Micrococcus lique. faciens Chester, Man. Determ Bact, 1901, 78; not Micrococcus liquefaciens Holland, Jour. Bact., 5, 1920, 224; Micrococcus alvi Chester, loc. cit., 81.)From the nasal mucous membrane. Winslow and Winslow (loc. cit., 199) state that this is apparently a synonym of Micrococcus albus Schrocter; while Hucker (loc. cit , 19) regards it as probably identical with Micrococcus freudenreichii Guillebeau or with Micrococcus ureae Cohn. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 251.

Micrococcus salivalis septicus, quoted from Wigura, see Cent. f. Bakt., I Abt., 17, 1895, 899. From the human skin.

Micrococcus sarcinoides Miguia. (Syst. d Bakt., 2, 1900, 168.) Hucker (loc. cit., 27) considers this identical with Micrococcus cinnabarcus Flugge.

Micrococcus seariosus Migula. (Stebert, Inaug Diss., Wurzburg, No. 1, 1894, 9; Migula, Syst. d. Bakt., 2, 1900, 91.) From a hairbrush. Winslow and Winslow (loc. cit., 199) state that this appears to be a synonym of Micrococcus albus Schroeter.

Micrococcus scarlatinosus Trevisan. (Trevisan, Batteri italiani, 1879, 19, Streptococcus rubiginosus Edington, Brit. Med. Jour, 1, 1887, 1285, Perroncitos scarlatinosa Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 20) From a scarlet fever patient.

Micrococcus scarlatinus Migula (Syst. d. Bakt., 2, 1900, 173) From feces

Micrococcus selenteus Brenner (Jahrb f. wissensch. Botan , 67, 1916, 85, Abst in Cent. f. Bakt., II Abt , 48, 1918, 431) From mud.

Micrococcus essibilis Zettnon (Cent I. Bakt, I Abt., Orug., 77, 1915. 216.) From dust Hucher (Loc. ct., 19) considers this a synonym of Micrococcus Fuedenrichi Guillebeau or of Micrococcus ureae Cohn. For a description of this species, see Bergey et al., Manual, 5th ed., 1839, 248.

Micrococcus septicus (Klobs) Cohn (Microsporon septicus Klebs, Die Ursachen der infectiösen Wundkrankheiten, 1871, and Zur path Anat. & Schusswunden, 1872; Cohn, Bettr z Böl. d Pfinnen, I, Heft 2, 1872, 164.) From pus

Micrococcus serophilus Costa. (Compt. rend. Soc. Biol., Paris, 83, 1920, 931) From acute articular rheumatism

Micrococcus serratus Migula (No. 15, Lembke, Arch f. Hyg. 26, 1898, 90.) Migula, Syst d. Bakt, 2, 1900, 200.) From feces Winslow and Winslow (loe cit, 2005) regard this as a synonym of Micrococcus candidus Cohn or of Gaffiya tetragena Trevisan.

Micrococcus sialosepticus Trevisan. (Coccus salivarius septicus Biondi, Ztschr f. Hyg., 2, 1837, 195; Coccus septicus Biond., ibid., 220; Trevisan, I generi e le specie delle Batteriacce, Milan, 1839, 33; Micrococcus saliarius Migula, Syst. d. Bakt., 2, 1900, 65; Micrococcus saliarius-septicus Chester, Man. Determ. Bact., 1901, 87.) From human salva. Winslow and Winslow (loc. cit., 205) consider this a synonym of Micrococcus candidus Cohn or of Gaffkya tetragena Trevisan.

Micrococcus siccus Migula. (Micrococcus No. V, Adamets, Landwirtsch. Jahrb., 18, 1880, 241; Migula, Syst. d. Bakt., 2, 1900, 124.) From Emmethal cheese. Winslow and Winslow (loc. cit, 185) state that this is probably a synonym of Micrococcus aurantaeus Cohn, while Hucker (loc. cit., 7) considers it a synonym of Micrococcus luteus Cohn or of Micrococcus arians Migula.

Micrococcus tarians Miguia.

Micrococcus similis Dyar. (Ann. N. Y Acad Sci., 8, 1805, 347.) From dust.

Winslow and Winslow (loc ett., 205) regard this as a synonym of Micrococcus

candidus Cohn or of Gaffkya tetragena Trevisan.

Micrococcus simplex Wright. (Mem. Nat. Acad. Sci., 7, 1895, 432.) From Schuykill River water Winslow and Winslow (loc cit., 199) state that this appears to be a synonym of Micrococcus abus Schroeter.

Mierococcus esimulans DeToni and Trevisan. (Micrococcus estreus II, Maggiora, Giorn Soe Ital. d'Igene, III, 1839, 354; DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1079.)

Micrococcus sordidus Schroeter (Schroeter in Colm, Kryptogam -Flora v Schlesien, 3, 1, 1886, 145) Winslow and Winslow (loc. ct., 224) state that this is apparently a synonymof Micrococcus candicans Flugge.

Micrococcus sphaeroides Gray and Thornton. (Cent. f Bakt, II Abt., 73, 1928, 74) From manure and soil For a description of this species, see Bergey et al., Manual, 5th ed, 1939, 259.

Micrococcus staphylophagus Serbinov.

(La Defense des Plantes, Leningrad, 2, 1926, 556; see Rev. Appl. Mycol., 5, 1926, 650) Considered pathogenic on grape-

vines.

Micrococcus stellatus (Lustig) Frankland and Frankland. (Stern-Coccus, Maschek, Jaliresber. d. Korn. - Oberreal-schule, Leitmeritz, No. 10, 1887, 62; Coccus stellatus Lustig, Diag. d. Bakt. d. Wassers, 2 Aufi., 1893, 40; Frankland and Frankland, Micro-organisms in Water, 1894, 503) From water Winsolw and Winslow (loc ctt., 220) regard this ns a synonym of Micrococcus luteus Cohn.

Micrococcus strobiliformis Migula. (No. 23, Lembke, Arch f. Hyg., 26, 1896, 315; Migula, Syst. d. Bakt., 2, 1900, 203.) From feces Winslow and Winslow (loc. cit, 220) regard this as a synonym of

Micrococcus luteus Cohn.

Micrococus subcardicans Lavanehy. (Univ. Genève, Inst. bot. Prof. Chodat, Sér 8, Fasc 12, 1914, 68, Abst in Cent. f. Bakt, II Abt, 47, 1917, 611.) From writer of Lake Geneva.

Micrococcus subcanus Migula. (No 17, Lembke, Arch. f Hyg., 26, 1806, 311; Migula, Syst d. Bakt. 2, 1900, 202) From feces Winslow and Winslow (loc. ct., 224) state that this is apparently a synonym of Micrococcus conditans

Flugge.

Micrococcus subcarneus Migula (Micrococcus carnicolor Kern, Arb bakt
Inst. Kralfsuhe, I, Heft 4, 1897, 495, 406
Micrococcus carnicolor Frankland and
Frankland, Micro-organisms in water,
1894, 503; Migula, Syst d. Bakt,
1894, 503; Migula, Syst d. Bakt,
1900, 181.) From the intestines of doves
(Columba luna and Columba oreas)
Hucker (loc. c.l., 26) states that this may
be identical with Micrococcus roseus
Flugge.

Micrococcus subcitreus Migula. (Gitronengelber Micrococcus, Keek, Ueber das Verhalten der Bakterien im Grundwasser, Dorpat Dissertation, 1890, 60; Migula, Syst. d. Bakt. 2, 1900, 147.) Fromair and water Winslow and Winslow (loc. ctt., 216) consider this a synonym of Micrococcus flavus Trevisan. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 249.

Micrococcus subcretaceus Migula (Kreideweisserverflussigender Micrococcus, Keek, Inaug. Diss., Dorpat, 1890, 64; Migula, Syst. d. Bakt., 2, 1900, 107.) Winslow and Winslow (loc. cit, 199) state that this species appears to be a synonym of Micrococcus ablus Schroeter.

Micrococcus subflavescens Bergey et al (Manual, 1st ed., 1923, 61.) From dust and water. Hucker (loc. cit., 9) considers this a synonym of Micrococcus flavus Trovisan. For a description of this species, see Bergey et al., Manual,

5th ed., 1930, 246.

Micrococcus subflavidus Migula. (Micrococcus letragenus subflavia v. Besser, Beitr. z. aligm. Path. u. path. Anat., 6, 1889, 347; Migula, Syst. d. Bakt., e, 1900, 190; Micrococcus subflavus Chester, Man Determ. Bact., 1901, 96; not Micrococcus subflavus Flugge, Die Mikroorganismen, 2 Aufl., 1886, 150.) Trom normal nasi mucus. Winslow and Winslow (loc. cit 184) state that this is apparently a 830 onym of Micrococcus aureus Zopf; while Hucker (loc. cit., 7 and 21) considers i probably identical with Micrococcus luteus Cohn, Micrococcus varians Migula or Gafkya letragena Trevisan.

Micrococcus subflavus Flügge. (Gelbweisser Diplocaccus, Bumm, Die Mikrogonorrh. Schleimhauterkr., 1 org d Aufl., 1885 and 2 Aufl., 1887, 20; Flügge, Die Mikroorganismen, 2 Aufl., 1886, 159, Neisseria subflava Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 32; Diplococcus subflavus Lisenberg, Bakt. Diag., 3 Aufl., 1891, 307; not Micrococcus subflavus Chester, Man. Determ. Baet., 1901, 96.) From gonorrheal pus. Winslow and Winslow (loc. et , 216) consider this a synonym of Micrococcus flarus Trevisan. For a description of this species, see Bergey et al, Manual, 5th ed., 1939, 218.

Micrococcus subfuscus Matzuschita (Cent. f. Bakt., I Abt., 29, 1901, 383.) From dust. Similar to Micrococcus fuscus Adametz.

Micrococcus subgiteus Migula (Micrococcus gives Henrica, Arb. a bak. Inst Karlsruhe, I, Heft 1, 1894, 78, not Micrococcus giteus Losski, Inaug. Dess, Dorpat, 1833, 60, Migula, Syst d. Bakt, 2, 1900, 132.) From cheese Winslow and Winslow (ice cit., 220) regard this as a synonym of Micrococcus Inteus Cohn.

Micrococcus aubgranulatus Migela (Micrococcus circus granulatus Fraund, Inaug. Diss, Frlangen, 1893, 27, Migela, Syst. d. Hakt, 2, 1900, 149, Micrococcus granulatus v Bagarenski, Cent f Bakt, H Abt, 13, 1908, 7.) From the oral cavity. Winslow and Winslow (loc ct., 210) consider this a synonym of Micrococcus flavus Trevisan For a description of this species, see Bergey et al., Manual, 5th ed., 1909, 249.

Merococcus subgrasus Migula (Grauer Coccus, Maschek, Jahresb d Kom - Oherrealschule, Leitmeritz, No 8, 1887, 61, Migula, Syst d Bakt, £, 1900, 61) From water Winslow and Winslow (toc. cif., 1993) state that this appears to be a synonym of Mierococcus abbu Schroeter, while Hucker (toc. cif., 191) regards in as synonym of Mierococcus treate Colin.

Micrococcus sublactus Migula (No 27, Lemble, Arch f. Hyg., 29, 1897, 329, Migula, Syst. d Bakt, 2, 1900, 210) From feecs Winslow and Winslow (foc. cit., 190) state that this appears to be a synonym of Micrococcus aflows Schmoder, while Hucker (foc. cit., 10) regards it as a synonym of Micrococcus freudemerchis Guillebeau or of Micrococcus ureae Cohn. Micrococcus worder Cohn. Micrococcus worder Cohn. Micrococcus worder Cohn.

20, Lembke, Arch. f. Hyg. 26, 1890, 317; Migula, Syst. d Bakt. 2, 1900, 205) From feces Hucher (loc cit, 15) considers this a synonym of Micrococcus albus Schroeter.

Micrococcus subluteus Weiss (Arb.

bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 198.) From vegetable infusions

Micrococcus subniteus Migula (Micrococcus elbidus Henrici, Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 75; not Micrococcus elbidus Losski, Inaug Diss., Dorpat, 1893, 55, Migula, Syst. d. Bakt, 2, 1900, 105.) From Swiss cheese. Winslow and Winslow (Roc. et 1, 190) state that this appears to be a synonym of Micrococcus albus Schreetes.

Micrococcus subochraceus Migula. (No. 39, Lembke, Arch. f. Hyg., 29, 1897, 332, Migula, Syst. d. Bakt., 2, 1909, 215.)
From feces. Winslow and Winslow (loc. cit., 216) regard this as a synonym of Micrococcus flavus Trevisan

Micrococcus subroscus Migula (Micrococcus roscus Insenberg, Bakt. Diac, 3 Aufl., 1891, 405; Migula, Syst. d. Bakt., 2, 1909, 176, Micrococcus rubescens Chester, Man Determ. Bast., 1901, 103; From the sputum of an influence patient Hueker (so. cit., 29) states that this may be identical with Micrococcus roscus Fluence.

Micrococcus subterraneus Hansgirg (Hansgirg, Oest Bot Zeitachr, 1858, No 7-8, 8, Stophylococcus subterraneus DeToni and Trevisun in Saccardo, Syllege Fungorum, 8, 1889, 1075 ) Trom damp walls of wine cellars in Bohemua

Micrococus subtilis Migula. (Diplococcus, Kirchner, Ztschr f. 113 g., 9, 1890, 528, Migula, Syst d Bakt, 2, 1300, 192.) Found in the sputim and Flood of influenza patients

Micrococcus arculentus Henrici. (Arb. bakt Inst Karlsrube, 1, Heft I, 1694, 63 ) From Swiss cheese. Winslow and Winslow (foc. cit., 224) state that this is apparently a synonym of Micrococcus candidans Plugge.

Metrococcus sulphurcus Zimmermann (Bakt unserer Trink- u. Nutzwässer, Chemnitz, I Reihe, 1890, 81.) From water. Winslow and Winslow (Ioc etl., 20) regard this as a synonym of Micrococcus Intens Cohn.

Micrococcus suis Burrill. (Bacillus

suis Detmers, Rept. U. S. Dept. Agric. for 1878; Burrill, Amer. Nat., 17, 1883, 320.) From blood of logs sick with

swine plague or hog eholera.

Micrococcus syphiliticus Migula. (Coccen, Disse, Deutsche med. Wehnsehr., 13, 1837, 883; Migula, Syst. d. Bakt., 1900, 218.) This may be synonymous with Micrococcus candicants Flügge. Micrococcus tardynadus Trevisan.

(Micrococcus flavus tardigradus Flugge, Die Mikroorganismen, 2 Aufl., 1886, 175; Trevisan, I generi e le specie delle Batteriaece, Milan, 1889, 31; Micrococcus sulfureus β-tardigradus Lelimann and Neumann, Bakt. Diag , 1 Aufl., 2, 1896, 163; Micrococcus sulfureus var. tardigradus Lohnis and Pillai, Cent. f. Bakt., II Abt., 19, 1907, 92.) From air; also found in water Winslow and Winslow (loc cit, 220) regard this as a synonym of Micrococcus luteus Colin. Micrococcus tardior Migula (Diplococcus flavus liquefaciens tardus Unna and Tommasoli, Monatshefte f. prakt. Dermatol., 9, 1889, 56; Migula, Syst. d. Bakt , 2, 1900, V and 141; Micrococcus epidermis Chester, Man. Determ. Baet., 1901, 97; Diplococcus flavus-liquefaciens Chester, ibid.) From eczema. Winslow and Winslow (loc. cit., 216) regard this as a synonym of Micrococcus flavus Trevisan, while Hucker (loc cit., 11)

Micrococcus tardissimus (Trevisan) Migula. (Milchweisser Micrococcus, Bumm, Mikroorg. d. gonorrh. Schleimhauterkr., 1 Aufl., 1885; Diplococcus albicans tardissimus Flugge, Die Mikro- . organismen, 2 Aufl , 1886, 183; Neissersa tardissima Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 32; Micrococcus albicans tardissimus Sternberg, Man. of Bact., 1893, 882; Migula, Syst. d Bakt., 2, 1900, 49 ) Found in vaginal secretions Winslow and Winslow (loc. cit., 205) regard this as a synonym of Micrococcus candidus Colin or of Gafflya tetragena Trevisan; while Hucker (loc.

regards it as a synonym of Micrococcus

citrous Migula.

cut., 7) considers it a synonym of Micrococcus lutcus Cohn or Micrococcus varians Migula.

Micrococcus tardus Migula. (Diplococcus albicans tardus Unna and Tommasoli, Monatshefte f. prakt. Dermatol., 9, No. 2, 1889, 49; Micrococcus albicans tardus Sternberg, Man. of Bact., 1833, 832; Migula, Syst. d. Bakt., 2, 1900, 59; Micrococcus eccemae Chester, Man. Determ. Bact., 1901, 86). From eccema. Winslow and Winslow (dec. cit., 216 and 221) regard this as a synonym of Micrococcus flavus Trevisan or of Micrococcus flavus Trevisan or of Micrococcus candicans Flügge.

Micrococcus trnacatis Chester. (No 43, Conn, Storrs Agr. Exp. Sta. 7th Ann. Rept., 1895, 78; Chester, Man. Determ Bact., 1901, St.) From milk from Unguay. Winslow and Winslow (toc. cl., 220) state that this is apparently a synonym of Micrococcus condicans Flogge

Micrococcus tener Weiss. (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 200) From n vegetable infusion.

Micrococcus tenuissmus Migula. (Micrococcus cumulatus tenuis v. Besser, Beitr. z. path. Anat., 6, 1889, 347; Migula, Syst. d. Bakt., 2, 1000, 55; Micrococcus cumulatus Chester, Man. Determ. Bact, 1901, 87.) Frequently found in human nasıl mucus. Winslow and Winslow (loc. cit., 205) regard this as a synonym of Micrococcus candidus Cohn or of Gaffixu tetragena Trevisan.

Micrococcus tetragenus aurers Boutron. (Thèse, Paris, 1893; Abst. in Cent. f. Bakt., 16, 1894, 971.) Hucker (loc.cit, 21) regards this as a synonym of Gaffiya tetragena Trevisan.

Micrococcus tetragenus concentricus Schenk. (Allg. Wien. med. Zeitung, 1892, 81 and 92; Abst. in Cent. f. Bakt., 15, 1893, 720.) From feces. Motile.

Micrococcus tetragenus-pallidus Chester. (Alierococcus tetragenus pallidus, Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 331; Chester, Man. Determ. Bact., 1901, 83) From dust. Probably a variety of Micrococcus rersatilis Chester, see below.

Micrococcus tetragenus-viridus Chester. (Micrococcus tetragenus eurodus Dyar, Ann. N. Y Acad. Sci., 8, 1895, 354, Chester, Man. Determ. Bact., 1901, 102) From dust. Probably a variety of Micrococcus versatilis Chester, see below

Micrococcus tetras Henriei (Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 60, Pediooccus tetras Pribram, Klassifikation der Schizomyceten, 1933, 46) From cheese. Winslow and Winslow (loc. cit., 224) state that this species is apparently the same as Micrococcus candicans Flugge.

Micrococcus thermophilus Hansgirg (Ocstr. Bot. Ztschr, No. 3, 1888, 5) From hot springs.

Micrococcus toxicatus Burrill (Amer-Nat., 17, 1883, 319) From poison my and other plants in the genus Rhus

Micrococcus trachomatis Migula (Trachomococcus, Sattler, In Zehender, Klin. Monatsbl , 1881, Trachomococcus, Michel, Arch. I. Augenhelik , 16, 1886; Neisseria micheli Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 22; see Baumgarten, Lehrb d path Myhol. 1, 1890, 421; Migula, Syst d Bakt., 2, 1900, 67) Winslow and Wins low (loc. cit., 205) consider this to be a synony of Micrococcus candidas Colin or of Gofflya tetragena Trevisan

Microtoccus tributyrus Stark and Scheib. (Jour. Dairy Sci., 19, 1936, 210.) From butter.

Microeccus tritics Prilheux (Maladies des plantes agricoles, 1, 1895, 7, not Microeccus tritics Köck, Monathiefte f Landwirtschaft, 1909, 217, quoted from Lehmann and Neumann, Bakt Dag, 5 Aufl., 2, 1912, 633) Considered pathogenic on wheat.

Micrococcus tuberculosus Migula (No. 23, Lemble, Arch t. Hyg. 29, 1897, 325; Migula, Syst. d. Bakt., 2, 1900, 214.) From feces Winslow and Winslow (loc. ctt., 221) state that this is apparently a 8, nonymod Micrococcus condicana Higgs. Micrococcus typhoideus Migula. (Coccus A, Foutin, Bakt, Untersuch v. Hagel, Wratsch, 1880, No. 49 and 50; see Cent. f. Bakt, 7, 1800, 373; Mugula, Syst. d. Bakt, 2, 1800, 91; Micrococcus alpha Chester, Man Determ. Bact., 1901, 93 ; From hail. Winslow and Winslow (Ioc. cut., 199) state that this appears to be a synonym of Vicrococcus albus Schrocter; while Hucker (Ioc ett., 25) states that it may be identical with Micrococcus roseus Flierer

Micrococcus ulceris de Luca (Gazzetta degli Ospitali, 1886, Abst. in Cent. f Bakt. 1, 1887, 333; Micrococcus ulceris mollis de Luca, ibid) From the secretion of a venercal ulcer.

Micrococcus ulmi Brussoff (Cent. f. Bakt, II Abt, 65, 1925, 261.) Isolated from diseased elm trees.

Hierococcus umbilicatus Weiss (Arh. bakt Inst. Karlsruhe, 2, Heft 3, 1902, 186) From a bean infusion Hucker (loc cit, 12) considers this a synonym of Hierococcus aureus Zopf

Microceccus urea Migula (Torule ammoniacale, Pasteur, Ann de Chim, et de Phys, 3 sér, 64, 1862, 52; van Tieghem, Comp rend Acad. Sci., Paris, 58, 1861–210, Torula ureae Lea, Jour. of Physiol., 11, 1870, 226; Migula, in Engler and Prantl, Die natürl. Pflanzenfam, 1, Ia, 1893, 17) From urine May not be the same as Microceccus ureae Colon.

Micrococcus urnalbus De Toni and Trevisan (Micrococcus albus urinae Doyen, Jour d comaiss médic, No 14, 1859, 108, De Toni and Trevisan, in Saccardo, S. Biege Finaporum, 8, 1889, 1076) From urine. Hincker (Ice. et al. 15) consulers this a 93 ponym of Micrococcus albus Schroeter

Micrococcus uruguae Chester. (No. 40, Conn, Storra Agr. Ivp. Sta. 7th Ann. Rept., 1895, 78, Chester, Man Determ. Bact., 1901, 100) From milk from Urugusy. Windon and Window (de. et., 216) regard this as a synonym of

Micrococcus flavus Trevisan; while Hucker (loc. cil., 10) regards it as a synonym of Micrococcus conglomeratus Migula.

Micrococcus utriculosus Migula. (No. 20, Lembke, Arch. f. Hyg., 29, 1897, 327; Migula, Syst d. Bakt. 2, 1900, 199.) From feces Winslow and Winslow (loc. cit., 199) state that this appears to be a synonym of Micrococcus albus Schrooter.

Micrococcus rarians lactis Conn. (Storrs Agr. Exp. Sta. 12th Ann. Rept., 1900, 37.) From milk, cream, dust. According to Weigmann (In Lafar, Handb. d. techn Mykologie, 2, 1905, 13) this is identical with Staphylococcus mastitis albus Hucker (loc. cit., 11) regards it as a synonym of Micrococcus citreus Migula.

Micrococcus variococcus Muller-Thurgau and Osterwalder. (Cent. f Bakt., II Abt., 36, 1913, 236.) From wine.

Micrococcus versatilis Chester (Micrococcus tetragenus febris flavae Finlay; Micrococcus tetragenus versatilis Sternberg, Report on etiology and prevention of yellow fever, Washington, 1891, 164, Chester, Man Determ. Baet., 1901, 102.) Isolated from the excrement of mosquitoes which had sucked the blood of yellow fever patients; and from dust Winslow and Winslow (loc ett., 210) regard this as a synonym of Micrococcus flavus Trevisan.

Micrococcus versicolor Flugge. (Die Mikroorgamismen, 2 Aufl., 1886, 177.) From dust Winslow and Winslow (loc. ctt., 220) consider this a synonym of Micrococcus luteus Cohn.

Micrococcus resicae Heim. (Lehrb. d. Bakt, 2 Aufi, 1898, 297.) From acid urine Winslow and Winslow (loc cit., 224) state that this is apparently a synonymof Micrococcus candicans Flügge

Micrococcus vesicans Harman. (Jour. Path. and Bact, 9, 1904, 1) Considered the cause of veld sore, a disease of Africa and tropical Australia

Micrococcus resicosus Weiss (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 203.) From a vegetable infusion

Hueker (loc. cit., 8) considers this species identical with either Micrococcus luleus Cohn or Micrococcus rarians Migula.

Micrococcus vesiculiferus Migula. (No. 23, Lemble, Arch. f. Hyg., 29, 1897, 30); Migula, Syst. d. Bakt., 2, 1900, 211.) From feces. Winslow and Winslow (loc. cit., 220) regard this as a synonym of Micrococcus luteus Coh

Micrococcus vincenzii Chester. (Micrococcus tetragenus citreus Vincenzi, Ia Riforma Med., 1897, 758; Chester, Man Determ. Bact., 1901, 103.) From the submaxillary lymphatic gland of a child Winslow and Winslow (loc. cit., 220) regard this as a synonym of Micrococcus luteus Cohn.

Micrococcus wini Migula. (Micrococcus syrrogenes vini I, Kramer, Bakt. in Bezichungen z. Landwirtsch. u. d. landwirtsch. techn. Gewerben, II Teil, 1892, 139; Migula, Syst. d. Bakt., 2, 1000, 118.) From wine. Winslow and Winslow (loc cit., 199) state that this appears to hos syrnonym of Micrococcus albus Schroeis while Hucker (loc. cit., 2) considers it identical with Micrococcus luteus Coha or Micrococcus carcinas Migula.

Micrococcus viniperda Schroeter. (Schroeter in Cohn, Kryptog -Flora v. Schlesien, 3, 1, 1886, 144) From dust, feces, etc.

Micrococcus viscosus Bergey et al.
(Micrococcus lactis viscosus B, Conn.
Esten and Stocking, Storrs Agr. Exp.
Sta. Rept. for 1906, 109; Bergey et al.
Manual, 1st ed., 1923, 68.) From pasteurized milk. For a description of this
species, see Bergey et al., Manual, 5th
ed., 1939, 256. See Micrococcus lactis
viscosus Sternberg.

Micrococcus viscosus lactis Conn (Storrs Agr. Exp. Sta. 12th Ann Rept. 1900, 44.) From milk.

Micrococcus viticulosus l'lugge. (Die Mikroorganismen, 2 Aufl., 1886, 178.) From dust and water. Winslow and Winslow (loc. cit., 205) consider this to be a synonym of Micrococcus candidus Cohn or of Gaffkya tetragena Trevisan

Micrococcus vulgaris Eckstein (Zischr. f. Forst- u Jagdwesen, 26, 1894, 17; Abst. in Cent. f Bakt, 1 Abt, 18, 1895, 292; not Micrococcus vulgaris Wiss, Arb. bakt. Inst Karlsruhe, 2, Heft 3, 1902, 193.) From insects.

Micrococcus zanllogenicus (Freire)
Trevisan, (Cryptococcus zanthogenicus
Freire, Richerches sur la cause de la
fêvre jaune, Rio de Janeiro, 1831, Trevisan, I gencii e le specie delle Batteriace, Milan, 1839, 33 ) Isolated from
yellow fever and supposed by Freire to
be the cause of the disease Winslow
and Winslow (loc. crf., 199) state that
this appears to be a synonym of Microco-

cus albus Schroeter.

Micrococcus zenopus Schrire and Greenfield (Trans Royal Soc So Airca, 17, 1930, 300.) From an abscess in a toad (Xenopus ep.). For a description of this species, see Bergey et al, Manual, 5th ed, 1939, 213.

Micrococcus zerophilus Glage (Zischr. f. Fleisch- u Milchlygiene, 10, 1990, 145) From coating on surface of dry wurst and similar ment products

Micrococcus zeae Serbinov (La Defense des Plantes, 2, 1926, 516) From flour, grain and seedlings of corn Was thought to be a cause of pellagra in South Russia.

Micrococcus zonalus Hennet (Arb bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 68) From cheese. Winslow and Winslow (loc. cit., 224) state that this is apparently a synonym of Micrococcus candicans Hugge.

Planococcus cases Migula (Micrococcus No 111, Adametz, Landwirtsch Jahrb, 18, 1889, 210, Migula, Syst d. Bakt., 2, 1900, 270) From Emmenthal cheese.

Flanococcus localers Migula (Lossler, Cent f. Bakt., 7, 1890, 637, Migula, Syst d. Bakt., 2, 1900, 273.) From colony an an old gelatin plate

Planococcus luteus (Adametz) Migula

(Diplococcus luteus Adametz, Mittell. d. oestert. Vers. Station I. Brauerei u. Malzerei in Wien, Heft I, 1888, 30; Neuszeria lutea Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 32; Magula, Syst. d. Bakt, 2, 1900, 274.) Hucker (Do. ett., 9) considers this species a synonym of Micrococcus flavus Trevi-

Rhodococcus fulvus Winslow and Rogers (Jour. Inf. Dis., 8, 1906, 515; not Micrococcus fulvus Cohn, Beitr. 2. Biol. d. Pflanzen, f, Heft 3, 1875, 181.) From soil, sir and water.

Staphylococcus albicans Stigell. (Cent. f. Bakt., I Abt., Orig., 45, 1908, 489.) Probably intended for Micrococcus

albicans amplus Flugge.

Staphylococcus albus liquefacems Sternbors. (White liquefying staphylococcus, Escherich, Die Darmbakterien des Sauglings, Stuttgart, 1839, 685, Sternberg, Manual of Bact., 1833, 607.) Found occasionally in the feces of healthy infants

Staphylococcus albus non tiquefaciens Hinva (Sbornik lekafský, II, Prague, 1887, 12 pp., sec Cent. f. Bakt., 2, 1887, 688). Probably a synonym of Micrococcus albocercus Migula

Staphylococus anaerobust Heurlin, Glask Unters d Komgehaltes um Gemtalkanale d fiebernden Wedinerinnen, Helsungfor, 1910, 120 ) See Weinberg, Nativelle and Prévot, Les Miernbes Anaérobus, Paris, 1937, 1927; probably nat the same as Staphy'ococus anaerobust Hanm, Die puerperale Wundinfektun, Berlin, 1912 Incompletely described. From gental tract, Staphylococus anaerobus major Heur-

lin (loc cit, 120) From genital tract.

Staphylococcus anaerobius minor Heurlin (loc. cit, 120) From genital tract.

Staphylococus aureus sarcinformis Risenhaueli (Klin Monatebi f Augenheilkunde, Jahrg, 8, 1909, 257, Abst in Cent. f. Bakt., I Abt., Ref., 45, 1910, 757.) Staphylococus boirs Ford (Staphylococus puggenes boirs Lucet. Ann. Index. Past., 7, 1893, 327; Ford, Textb. of Bact., 1927, 424.) Found in suppurative lesions of cattle.

Stanhylococcus candidus Warrington. (Lancet, 1, 1888.)

Staphylococcus flavocyaneus Knaysi. (Jour. Baet., 43, 1912, 368.) Found as a eontaminant in dissociation studies.

Staphylococcus flavus non pyogenes Frankel and Sanger. (Arch. f. path. Anat., 108, 1887, 286; Abst. in Cent. f. Bakt., 3, 1888, 281.) Found in endocarditis ulcerosa

Staphylococcus griseus Tavel. (Quoted from Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 173 ) From pus.

Staphylococcus griseus radiatus Viti. (Atti d. R. Accad d. Fisiocritici di Siena, Ser. IV., 2, 1891, Abst. in Cent. f. Bakt., 11, 1892, 672 ) From cases of endocarditis.

Staphylococcus habanensis (Quoted from Fernandez, Cronica médico quirárgica de la Habana, 1891, No. 30, Abst. in Cent. f. Bakt., 11, 1892, 472.) Isolated from the human eye.

Staphylococcus insectorum Krassilstschik. (Quoted from Paillot, Les maladies du ver à soie grasserie et dysenterics, 1928, 171.) From the intestinal tract of the silkworm (Bombuz mors).

Staphylococcus lactis acidi McDonnell. (Inaug Diss , Kiel, 1899 , Abst in Cent. f. Bakt , II Abt., 6, 1900, 120 )

Staphylococcus lelotrit Trevisan erobe des périfolliculites conglomérées, Leloir, Soc. anatomique, May, 1884; Trevisan, I generi e le specie delle Batteriacec, Milan, 1889, 33.)

Staphylococcus liquefaciens aurantiacus Distaso (Cent. f. Bakt., I Abt., Orig , 59, 1911, 102.) From feces.

Staphylococcus muscae Glaser. (Amer. Jour. Hyg., 4, 1924, 411.) Causes a fatal infection in house flies (Musca domestica). For a description of this species, see Bergey et al, Manual, 5th ed, 1939, 264.

Staphylococcus non pyogenes Savor. (Beitr. z. Geburtshilfe u. Gynākol. v. Hegar, 2, Heft 1, 1898; Abst. in Cent. f. Bakt., I Abt., 26, 1899, 642.) From urino-genital traet.

Staphylococcus pharyngis Bergey ct al. (Manual, 1st ed., 1923, 56.) Found in the human nasopharyny in acute catarrhal inflammation. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 265.

Staphylococcus putrificus Schottmuller. (Leitfaden f. d. Klinisch- Bakt, Kultur-Methoden, Berlin, Wien, 1923. Quoted from Weinberg, Nativelle and Prévot, Les Microbes Anaérobies, Paris, 1927, 1027.)

Staphylococcus pyogenes liquefaciens albus Hlava. (Sborník lékařský, 11, Prague, 1887, 12 pp.; Abst. in Cent. f. Bakt., 2, 1887, 688.) From small pov pustules.

Staphylococcus pyogenes tenuis Scheibe (Inaug. Diss., Munchen, 1889; see Cent f. Bakt., 6, 1889, 186.) From middle ear infections.

Staphylococcus roseus Tavel. (Quoted from Lehmann and Neumann, Bakt Diag ,'1 Aufl., 2, 1896, 177.) Evidently identical with Micrococcus roseus Lebmann and Neumann or Micrococcus rosco-fulcus Lehmann and Neumann

Staphylococcus salivarius Andrewes and Gordon. (35th Ann. Rept. Local Govt. Board London, 1905-06, 558) From saliva. Probably Micrococcus candidus Cohn.

Staphylococcus ureae candidus Lundström. (Festschr. d. path.-anat. Inst. z. Andenken a. d. 250 jahrige Bestehen d finnland. Univ. Helsingfors, 1890; abst in Cent. f. Bakt., 9, 1891, 672) From Probably Micrococcus ureas urine Cohn.

Staphylococcus ureae non pyogenes Barlow. (Arch. f. Dermat. u. Syph., 1893; Abst. in Cent. f. Bakt , 14, 1893, 456.) From cases of eystitis.

Urococcus dowdeswelli Miquel. (Ann. de Mierographie, 5, 1893, 209.) Fer-

ments urea. Urococcus van tieghemi Miquel (loc. cit., 161). Ferments urea.

## Genus II. Gaffkya Trevisan,\*

(Trevisan, Atti d Accad Fiso-Medico-Statistica in Milano, Scr. 4, 5, 1885, 106; Tetracoccus Klocki, Cent. I Bakt., 15, 1891, 360, not Tetracoccus Orla-Jensen, The Lactic Acid Bacteria, Mêm. Acad Scs Danemark, Sec. Scs., 5 ser, 5, 1919, 151, Tetra-dipleoccus Bartoszewicz and Schwarzwasser, Cent. I. Bakt., II Abt., 21, 1908, 614.) Named for Pof. Georg Gaffky, 1850-1918, Berlim.

Occur in the animal body and in special media as tetrads, while in ordinary culture media they occur in pairs and irregular masses Aerobic to anaerobic. Gram-positive. Parasitic organism:

The type species is Gaffkya tetragena (Gaffky) Trevisan.

Key to the species of genus Geffkya.

- I. Facultative aerobe.
- II. Strict apperate

- 1. Gaffkya tetragena
- 2. Gaffkya anaerobia.
- 1. Gaffkya tetragena (Gaffky) Trevisan. (Vierococcus tetragenus Gaffly, Arch. f. Chirurg., 28, Heft 3, 1883, 500, Trevisan, Atti d Accad. Fisio- Medico-Statistica in Milano, Ser 4, 5, 1885, 106, Micrococcus tetragenus senticus Boutron, Thesis, Paris, 1893; Abst in Cent f. Bakt , 16, 1894, 971; Micrococcus tetragenus albus Boutron, shid : Merista septica Hueppe, Principles of Bacteriology (Ting. trans.), 1899, 170; Sarcina septica Hueppe, ibid.; Sarcina tetragena Migula, Syst. d. Bakt., 2, 1900, 225; Merirla tetragens Vuillemin, Ann. Mycologie, Berlin, 11, 1913, 525; Staphylococcus tetragenus Holland, Jour. Bact , 5, 1920, 221; Tetracoccus septicus Neveu-Lemaire, Précis Parasitol Hum , 5th ed , 1921, 15; Pediococcus tetragenus Pribram, Klassifikation der Schizomseeten, 1933, 46 ) From Greek, tetra (tetara), four, M L. genes, producing

Spheres: 0.6 to 0.8 micron in size, with pseudocapsule (in Isaly fluids) surrounding four of the elements showing typical tetrads. Gram positive Gelatin colonies: Small, 1 to 2 mm, in diameter, white convex.

Gelatin stab. Thick, white surface growth. No liquefaction.

Agar colonies Circular, white, smooth, glistening, entire Reimann (Jour Ract, 31, 1936, 285) has described eleven colony form variants for this species

colony form variants for this species
Agar elant: White, moist, ghistening.
Broth Clear, with gray viscous sedi-

Litmus milk : Slightly acid.

Potato White, viscul. Indole not formed

Nitrates not produced from nitrates. Starch not hydrolyzed.

Ammonium salts not utilized.

Acid from glucore, lactore and

No HrS lorned

terolác, facultative

Pathogenic for mice and guines pigs; rabbits less susceptible.

Optimum temperature 37°C.

Source: Isolated from sputum in tuberculosis, also from air and skin Habitat: Mucous membrane of respira-

tory tract

<sup>\*</sup>Revised by Prof. G. J. Hucker, N. Y. State Experiment Station, Geneva, New York, March, 1913.

 Gsfikya anaerobia (Choukévich) Prévot. (Tetracoccus anaerobius Choukévitch, Ann Inst. Past., 25, 1911, 389; Micrococcus tetragenes anaerobius Hamm, Die puerperale Wundinfektion, Berlin, 1912; Prévot, Ann. Sei. Nat., Sér. Bot., 15, 1933, 293 ) From Greek, an, without; aer, air, bos, life.

Spheres: About 1.0 to 1.5 microns, occurring in tetrads, sometimes in groups of eight Gram-positive.

Gelatin No liquefaction.

Deep agar colonies: After 24 to 48 hours, small, grayish, 2 to 3 mm. in diameter Abundant production of gas which breaks up the agar.

Broth, Poor growth. Slight sediment. Milk: Unchanged

Coagulated proteins not digested.

Optimum temperature 37°C. No growth at 22°C.

Non-pathogenic for guinea-pigs or rabbits.

Strict anaerobe.

Distinctive characters: Prefers acid

Source: Isolated from the female genital tract, isolated from the large intestine of a horse.

Habitat Probably widely distributed in natural cavities of man and animals

Appendix: The following species have been placed in the genus Gaffkya or in the genus Tetracoccus.

Gaffkya archeri Trevisan (A black micrococcus, Archer, Quart. Jour Microscop. Sci., 1874, 321; Trevisan, I generie le specie delle Batteriacee, Milan, 1889, 27.)

Gafikya grandıs DeToni and Trevisan. (Mıcrocoque des reins et des ulcéres syphilitiques de la peau, Babes, in Cornil and Babes, Les Bactér., 2nd ed., 1889, 782, DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1012.)

Gaffkya mendozac DcToni and Trev-

(Micrococcus tetragenus and Micrococcus tetragenus mobilis ventriculi Mendoza, Cent. f. Bakt., 6, 1889, 567; DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1043; Planococcus tetragenus Migula, Syst. d. Bakt., 2, 1900, 269: Micrococcus mendozae Chester, Man. Determ. Bact., 1901, 81; Sarcina letragena Winslow and Rogers, Jour. Inf. Dis. 3, 1906, 515; Planomerista ventriculi Vuillemin, Ann. Mycolog., Berlin, 11, 1913, 525.) Motile. Isolated from the contents of the stomach. Hucker (N. Y. State Exp. Sta. Tech. Bull. No. 102, 1921, 21) regards this as a synonym of Gaffkua tetragena Trevisan.

Gaffkya tardissima (Altana) Berger et al. (Tetragenus tardissimus Altana, Cent. f. Bakt., I Abt., Orig., 48, 1009, 42; Bergey et al., Manual, 2nd ed., 1925, 59.) From a natural infection of guinea pigs. See Manual, 5th ed., 1030, 260 for a

description of this species.

Gaffkya vernet! Corbet. (Organism. 21, Denier and Vernet, La Caoutcliouc, 17, 1920, 1919; Corbet, Quart
Jour. Rubber Research Inst., Malaya. 1,
1930, 113.) From the late of the Paratuber tree (Hevea brasiliensis). For a
description of this species, see Manual,
5th ed. 1939, 260.

Tetracoccus carneus halophilus Horowitz-Wlassown. (Cent. f. Bakt, II Abt., 85, 1932, 16.) Isolated from salted intestines (Wiener skins).

Tetracoccus casei Orla-Jensen. (The Lactic Acid Bacteria, 1919, 80.) From cheese. Probably identical with Micrococcus freudenreichii Guillebeau.

Tetracoccus mastitidis Orla-Jensen (cc. cit., 81). From milk of a woman nih mastitis. Orla-Jensen thinks this is identical with the staphylococcus that causes mastitis in cows, i.e., Micrococcus pyogenes var. aureus Zopf.

Tetracoccus mycodermatus Orla-Jensen (loc. cit., 81). From Camembert cheese

## Genus III. Sarcina Goodsir.\*

(Goodsir, Ldinborough Med and Surg. Jour., 1812, 430; Lactovarvina Beijerinek, Arch. nicri. d. sci. evact., Scr. 2, 13, 1903, 339; Urosarcina Miquel, Ann. Microg., t., 1858, 817; Planosarcina Miguel, Arb Bakt. Inst Karlsruhe, I, 1891, 236; Pesudosarcina Lünis, Ilandb d landwirtsch Bakt., 1910, 440 (Pseudo-sarcina, Mazé, Compt. rend. Acad. Sci. Paris, 137, 1903, 857), Sporosarcina Orla-Jensen, Cent. I. Bakt., 1811, 1842, 1909, 340; Paulosarcina Enderlein, Sitzher. Gesell. Naturi., Berlin, 1917, 1917; Plancelium Enderlein, ibid., 319, Zymosarcina Smit, Die Gärungssarcinen. Pflanzenforschung, Helt 14, 1330, 28, Bulyrisarcina Kluyver and Van Niel, Cent. f. Bakt., II Abt., 94, 1936, 400, Methanovarcina Kluyver and Van Niel, ibid.) From Latin sarcina, packet, bundle

Division occurs, under favorable conditions, in three planes, producing regular packets. Usually Gram-positive Grow th on agar abundant, usually with formation of yellow or orange pigment. Glucose both slightly acid, lactose both generally neutral. Gelatin frequently hquefted. Nitrites may or may not be produced from nitrate: Saropolytes and facultative pursues.

The type species is Sarcina centriculi Goodsir.

## Key to the species of genus Sarcina.

I. Microaerophilie to anaerobie

- A. No grouth without sugars Do not produce methane. Sub-genus Zymo-sarrina Smit (Die Garungs-arenne Pflanzenforschung, Heft 14, 1930, 26).

  1. Cellulant Coulom pouttre. Slow congulation in littings milk
  - 1. Cellulose reaction positive Slow congulation in litmus

    1. Sarcing rentricult.
  - 2 Cellulose reaction negative. Litmus milk not congulated,
- B. Daes not utilize sugars Produces mettane Sult-genus Methanosareina Kluyver and van Niel (Cent. f. Bakt., H. Ald., 94, 1936, 400).
  - 3. Sareina methanica.

## II Aerobic.

- A. No endospores present. Sub genus Sareinococcus subgen, nor
- 1. Not halophilie
  - a. Non-motile.
    - b. Yellow pigment produced. Nitrates not produced from nitrates.
       c. Milk alkaline, congulated.
      - 4 Sarcina fulca.
      - ee Milk alkaline; not congulated
      - 5 Sarcina flara.
    - bb. Orange pigment produced Nitrites produced from nitrates
    - na. Mobile.

  - 2. Halpplishe red chromogen

    8. Sarcina filtorolis
  - B. Indespores present Motile. Sub-genus Sporaigreina Orla Jensen (Cent. f Bakt., 11 Abr., 22, 1979, 319)
    - 9. Sarcina ureze.

7 Sareina citrea.

<sup>\*</sup> Revised by Prof. Robert S. Breed, New York State Experiment Station, Geneval New York, March, 1913

1. Sarcina ventriculi Goodsir. (Goodsir, Edinborough Med. and Surg. Jour. 57, 1812, 430; Mertsmopeda goodsrri F1, 1812, 430; Mertsmopeda goodsrri Husemann, De anim. et végét., 18—, 13; Merismopeda ventriculi Robin, Histoire des végét. parasites, 1853, 313, Anaerobie sarcina, Beijerinek, Proc. of Section of Sciences, Kon. Akad. v. Wecheselt., Amsterdam, 7, 1905, 580; Zymosarcina rentriculi Smit, Die Gärungssarcinen. Pflanzenforsehung, Jena, 116t 14, 1930, 26; Sarcina beyerineki Prévot, Ann. Sci. Nat., Sér. Bot., 16, 1933, 205.) From Latin, rentriculus, the stomach.

Description taken in part from Smit (loc. cit.).

Largo spheres: 3.5 to 10 microns, occurring in packets of 8, 16, 32 or more elements. Non-motile. Grant-positive. Gellulose reaction positive

Growth occurs only in sugar media, containing peptones

Gelatin : No liquefaction.

Deep glucose agar colonies: Multilenticular, surrounded by n cloudy zone. Abundant gas

Glucose ngar slant Round, whitish colonies, several millimeters in dameter. Glucose broth: Abundant, flaky

growth. Abundant gas. Acid. N turbidity.

Plain peptone water: No growth Sugar peptone water: Abundant growth. Gas. Indole not formed Milk: Slow growth Acid and co-

agulation.

Coagulated proteins not attacked.

Acid and gas from glucose, fructose, sucrose, maltose, lactose and galactose. No acid from vylose, arabinose, raffinose, mannitol, dulcatol, salicin, starch, glyccrin and inulin.

Neutral red broth changed to fluorescent yellow.

Utilizes peptones, wart and yeast water as sources of nitrogen Connot utilize amino acida or inorganic nitrogen.

Principal products of metabolism are carbon dioxide and ethyl alcohol. Nitrites not produced from nitrates Non-pathogenic.

Optimum pll 1.5 to 50. Limits of pll 0.9 to 9.8.

Temperature relations: Optimum 30°C. Maximum 45°C. Minimum 10°C. Kille in ten minutes at 65°C.

Microaerophilic to anaerobic.

Source; Isolated from a disease stomach.

Habitat: Garden soil, dust, sand, mud the stomach.

Sarcina maxima Lindner. (Lindner, Die Sarcina-Organismen der Grungsgewerbe. Inaug. Diss., Berlin, 1885
 Also abstract in Cent. f. Bakt
 1888, 427; Zymwarcina maxima Smit Die Gärungssarcinen. Pflancnforten ung, Heft 14, 1930, 22; Butyrisarcam maxima Kinyver and van Nicl, Cent. I Bakt., II Abt., 94, 1936, 400.) Fent Latin maxima, largest.

Description from Weinberg, Nativelle and Prevot, Les Microbes Anaérobies 1937, 1939 and from Smit, loc. cit.

Large spheres: 4.0 to 4.5 mlcrons, or curring in regular packets of 8, 16, 32 of more elements. Non-motile. Grampositive.

Growth occurs only in sugar media, containing pertones.

Gelatin: No liquefaction.

Deep glueose agar colonies: Multilenticular. Abundant gas produced. Glucose agar slant: Round, whitish

colonies
Glucose broth: Abundant growth,

flaky, gaseous, marked acidification. Disagreeable butyric odor. No turbidity. Sugar peptone water: Abundant

Sugar peptone water: Abuse growth, flaky, gaseous, followed by seidification.

Milk: Not congulated.

Congulated proteins not attacked. Cellulose reaction negative.

Cellulose reaction negative.

Acid and gas from glucose, fructose, galactose, maltose, sucrose and lactose.

Neutral red broth changed to finorescent yellow. Utilizes peptones, yeast water or broth as source of nitrogen. Cannot utilize amino acids or inormanic nitrogen

Principal products of metabolism are carbon dioxide, butyric and acetic acids. Non-pathogenic.

Limits of pH 1.0 to 9 5.

Temperature relations. Optimum 30°C Maximum 40°C. Minimum 15°C. Killed in twenty minutes at 55°C

Microaeropbilie to anaerobic

Source: Isolated from fermenting malt mash.

Habitat: Acidified flour pastes, wheat bran; seldom in soils. Also intestinal contents of guinea pigs (Crecclius and Rettger, Jour. Bact., 46, 1943, 10).

Sarcina methanica (Smt) Weinberg et al. (Methansareine, Sobogen, Inaug. Diss., Delft, 1906, 104, Zymesarcina methanica Smit, Die Garungssarcina methanica Smit, Die Garungssarcina Pfanenforschung, Heft 14, 1930, 25; Methanosarcina methanica Kluyver and Van Niel, Cent. I. Dakt., II Abt., 94, 1936, 402; Barker, Arch. I. Mikrobol, 7, 1936, 420; Barker, Arch. I. Mikrobol, 7, 1936, 420; Meinberg, Nativelle and Prévot, Les Microbes Annérobles, 1937, 1032.) From M. L. methanium, methanie; M. L. methanium, related to methane.

Description from Weinberg, Nativelle and Prévot (loc. cit) and Smit (loc cit) Spheres: 20 to 25 microns, occurring

in packets of 8 or more cocei. Non-motile. Gram-variable.

Growth in solutions of calcium acetate

and possibly butyrate and inorganic ammonium salts. Carbon dioxide is needed forgrowth.

In acetate agar (with addition of some Il<sub>2</sub>S and NalICO<sub>3</sub>): Colonies of 50 to 100 microns are formed, showing gas formation.

Cultural characters as yet unknown. Peptones not attacked.

Cellulose reaction negative.

Utilizes ammonium salts as source of nitrogen. No organic nitrogen compounds utilized. Carbobydrates not fermented. Etbyl alcohol is not fermented.

Principal products from the metabolism of calcium acctate and butyrate are methane, carbon dioxide and calcium carbonate.

Non-pathogenic.

Optimum temperature 35° to 37°C.

Strict anaerobe. Killed by a short contact with the air.

Distinctive characters: Utilizes ammonium salts and acyclic acids producing methane and carbonic acid.

Source: Sediment in methane fer-

mentation (Weinberg et al.). Isolated from mud (Smit).

Habitat: Swamp waters and mud; fermenting sewage sludge.

4 Sarcha lutea Schroeter (Kryptog Flora v. Schlesen, § 1, 1885, 181; also see Klein, Mercorganisma and Disease, 1885, 43, Eusenberg, Bakt. Dag., I Aud., Tat 2, 1885; Fluge, Die Mikroorganismen, 2 Auf., 1885, 179, Frankland and Frankland, Phil Trans. London, 178, B, 1888, 265.) From Latin Luteus, yellow.

Spheres 1.0 to 15 microns, showing packets in all media. Gram-positive. Gelatin colonies Circular up to 5 mm. in diameter, sulfur-yellow, sinking into the medium.

Gelatin stab Slow infundibuliform Inquefaction

Agar colonies. Yellow, coarsely granular, circular, raised, moist, glistening, entire margin

Agar slant. Sulfur to chrome yellow, smooth, soft

Broth Clear with abundant yellow sediment

Latmus milk Congulated, becoming ulkaline

Potato Sulfur to chrome yellow,

Shight indole formation

Nitrites generally produced from ni-

No acid from glucose, lactose or sucrose.

Hydrogen sulfide is formed.

Aerobic.

Optimum temperature 25°C. Habitat: Air, soil and water, akin surfaces

5. Sarcina flava De Bary. (Vorlesungen uber Bakterien, 1887, 151; Sarcina liquefaciens Frankland and Frankland. Philos. Trans. Roy. Soc. London, 178, B. 1888, 267.) From Latin, flavus, yellow. Spheres: 1.0 to 20 microns, occurring in packets of 16 to 32 cells. Gram-posi-

Celatin colonies: Small, circular, yellowish.

Gelatin stab: Slowly Inquefied.

Agar slant: Yellow streak

Broth: Slowly becoming turbid with whitish, later yellowish scdiment.

Litmus milk: Alkaline, not coagulated. Potato. Yellow streak

Indols not produced.

Nitrites not produced from nitrates. Acrobic.

Optimum temperature 30° to 35°C Habitat: Air, water, soil

6. Sarcina aurantiaca Flugge Mikroorganismen, 1886, 180; For description see Frankland and Frankland, Phil. Trans. Roy. Soc. London, 178, B, 1888, 266; Paulosarcina aurantiaca Enderlein, Sitzungsber, Ges Naturf, Freunde, Berlin, 1917, 319.) From M. L. aurantiacus, orange-colored.

Spheres developing packets in all

media. Gram-positive.

Gelatin colonies: Small, circular, dark vellow, entire margin, sinking into the medium.

Gelatin stab: Infundibuliform liquefaction.

Agar slant: Slightly raised, orange yellow to orange red, soft, smooth.

Broth. Flocculent turbidity, with abundant sediment.

Litmus milk: Coagulation and digestion.

Potato: Raised, yellow-orange, glistening to dull, granular.

Slight indole formation.

Nitrites not produced from nitrates. No H2S produced.

Aerobie.

Optimum temperature 30°C. Habitat: Air and water.

7. Sarcina citrea (Migula) Bergey et al. (Micrococcus agilis citreus Monge, Cent. f. Bakt., 12, 1892, 52; Planococcus cuireus Migula, Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 236; Micrococcus agilisculreus Chester, Man, of Bact., 1901, 115; Bergey et al., Manual, 1st ed., 1923, 74.) From M. L. citreus, lemon-yellow. Spheres: 0.6 to 0.8 micron, occurring singly, in pairs and in packets. Motile, possessing a single flagellum. Gram-

positive. Gelatin colonies: Small, circular, yellowish, entire, becoming citron-yellow to orange.

Gelatin stab: No liquefaction.

Agar colonies: Small, yellow, conver, entire, smooth, glistening.

Agar slant : Abundant, yellow, plumose, glistening, taking on an orange color with age.

Broth: Turbid.

Potato: Abundant, yellow growth.

Indole not formed.

Nitrites not produced from nitrates Aerobie.

Optimum temperature 25°C.

Habitat: Air.

8. Sarcina littoralis Poulsen. (Poul sen, Vidensk. Meddel, naturh. Foren. i Copenhagen, 1879-80, 231-254; Sarcina morrhuae Farlow, U. S. Fish Commission Report for 1878, 1880, 974, Micrococcus a, Høye, Bergens Museums Aarbog., No 7, 2 Hefte, 1901, 39; Micrococcus literalis Kellerman, Cent f Bakt., II Abt., 42, 1915, 399.) From Latin, litus (littus) -toris, the sea shore; -alis,

relating to. The relationships of the following to each other and to Sarcina littoralis are not clear:

· Eruthroconis Interalis Ocrated. turh. Tidsskrift, 3, 1840-41, 555. Merismonedia literalis Rabenhorst, Flora Europ. Algarum, 2, 1864-65, 57, Sarcina littoralis Winter in Rabenhorst, Kryptogamen-Flora, 1, I Abt., 1881, 50, Pediococcus litoralis Trevisan, I genera e le specie delle Batteriacee, Milano, 1889, 28; Lampropedia littoralis De Tom and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1049,)

Conjothecrum bertherand; Mégnin (Revue Mycologique, 6, 1884, 197) Saccardo and Berlese (Atti del R Instituto Veneto, Ser. VI, Vol. 3) consider C bertherandi to be identical with Sarcina littoralis, while Zopf (Die Spaltpilze, 2 Auff., 1884, 73: 3 Auff., 1885, 102) considers C. bertherandi a stage of Beggiatoa roseo persicina.

Description taken from Lochhead (Can Jour. Res . 10, 1931, 280).

Spheres: 1.2 to 16 microns occurring singly, in pairs, in fours, in short chains, and in packets, the arrangement varying with medium, temperature, salt concentration and age of culture Non-motile Gram stain variable, with rather more positive than negative cells

No growth in ordinary media

Salt gelatin: Growth slow, with no liquefaction.

Starch media (20 per cent salt) · Colonies usually 1 to 3 mm, round, entire, convex, with a waxy appearance, brick red with a pale border, color appearing gradually.

Starch media slants (20 per cent salt): Filiform, slightly raised, entire edge Coral red in color. Slight decrease in shade as cultures age.

Liquid media . No growth

Potato: In 20 per cent salt, scanty growth. Slight chalky pink development near the top. Indole not formed.

Nitrates reduced to nitrites.

Diastatic action negative.

Acrobic, obligate

Halophilic, obligate, 16-32 per cent salt. Optimum 20-21 per cent.

Optimum temperature 37°C.

Source: Isolated from seashore mud near Copenhagen.

Hahitat. Sea water brine, or sea salt. Isolated from salted hides and salted fish.

The following is believed by Kellerman (loc. cit ) to be a variety of Sarcina Inttoralis .

Drolacoccus gadidarum Beckwith (Beckwith, Cent f, Bakt., I Abt, Orig., 60. 1911. 351: Micrococcus litoralis gadidarum Kellerman, Cent. f. Bakt., II Abt., 42, 1915, 400; Pediococcus gadida. rum Pribram, Klassification der Schizomyceten, 1933, 46 ) From reddened salted codfish.

9. Sarcina ureae (Beijerinck) Löhnis. (Planosarcing ureae Beijerinch, Cent. f. Bakt , II Abt., 7, 1901, 52, Löhnis, Landwartsch bakteriol Prakticum, 1911, 138; Sporosarcina ureae Kluvver and van Niel, Cent f. Bakt, II Abt., 94, 1936, 401 ) From Greek, urum, urine, M. L., urea, urca

Probable synonym Sarcina psychrocarteries (Rubentschick) Bergey et al. (Urosarcina psychrocarterica Rubentschick, Cent f Bakt, II Abt., 64, 1925, 168, abid, 66, 1926, 161; abid, 67, 1926, 167, thid , 68, 1926, 327, Bergey et al., Manual, 3rd ed., 1930, 95 )

Solieres 07 to 12 mierons, occurring sangly, in pairs and in packets. Atypical endospores present Motile, possessing nentrichous flagella, Gramlong positive. Gelatin colonies. Small, circular, flat,

tough, vellowish. Converts urea into ammonium car-

bonate.

Aerobie.

Optimum temperature 20°C. Resists heating to S0°C for 10 minutes Source: Isolated from urine.

Appendix: The following names appear in the literature, and are listed here chiefly for their historical interest. Many are inadequately described, and probably many are synonyms.

Micrococcus aurantiacus Pagliani, Maggiora and Fratim. (Pagliani et al., 1837; Pediococcus aurantiacus Trevisan, I generi e le specie delle Batteriacee, Milan, 1839, 25; Mcrismopedia aurantiaca Maggioria, Giorn. Soe ital d'Igiene, 11, 1839, 355; Pediococcus maggiorae De Toni and Trevisan, in Saceardo, Sylloge Fungorum, 8, 1839, 1031.) From skin of the buman foot.

Planosareina samesii Migula. (Eine bewegliche Sarcine, Sames, Cent. I. Bakt., II Abt., 4, 1898, 661; Migula, Syst. d. Bakt., 2, 1900, V and 278; Sarcina agilis Matsuschita, Zeit. f. Hyg., 35, 1900, 496) From liquid manure. Probably identical with Sarcina ureae Lohnis.

Sareina acidifeans Migula. (Sareina No VIII, Adametz, Landwirtsch. Jahrb., 18, 1859, 243; Migula, Syst. d. Bakt., 2, 1900, 253 ) From cheese. Winslow and Winslow (The Systematic Relationships of the Coccaccae, 1903, 235) regard this species as a variant of Sareina lutea Schroeter.

Sareina agilis Saito (Jour. Coll. Science Imp. Univ. Tokyo, 25, 1908, 68; abst in Cent. f. Bakt, II Abt., 24, 1909, 228) From dust.

Sareina alba Zimmermann. (Weisse Sareina, Maschek, Bakt. Untersuch. d. Leitmeritzer Trinkwasser, 1857, 64, Zimmermann, Die Bakterien unserer Trinku. Nutzwasser, Chemnitz, I Reihe, 1899, 90.) From water. Zimmermann reported the presence of spores; subsequent workers failed to observe spores, even when working with original cultures.

Sareina alba var. incana Appel. (Ber. d. landw. Inst. Konigsberg, Heft 5, 1900, 89; quoted from Lohnis, Cent. f. Bakt., II Abt., 18, 1907, 146) Frequently found in milk Closely related to Adametz's Sareinae Nos VII, VIII and IX.

Sarcina albida Gruber (Arb. bakt. Inst. Karlsruhe, 1, Hoft 3, 1895, 256) Fröm the stomach contents of a man with stomach cancer. Sarcina alutacca Gruber (loc. cit., 221). From leaven.

Sarcina aurea Macé. (Traité Pratique de Bact., 2nd ed., 1892, 371; not Sarcina aurea Henrici, see below.) From lung exudate. Possesses active oscillary motility, but no flagella.

Sarcina aurea Henrici. (Arb. bakt. Inst. Karlsruhe, I, Heft 1, 1894, 91; Sarcina aurescens Gruber, ibid., Heft 3, 1895, 203.) From Swiss cheese. Winslow und Winslow (Ioc. cit., 233) regadthis species us a variant of Sarcina face De Bary which has acquired certain fermentative powers.

Sarcina aurescens var. mucosa Jaiser; quoted from Pribram, Klassifikation der Schizomveeten, 1933, 44.

Sareina bicelor Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1897, 505.) From the stomach of a woodpecker (Picus major). Winslow and Winslow (loc. cit., 232) regard this species as identical with Sarcina fara De Bary.

Sarcina butyrica Migula. (Sarcina No. XI, Adametz, Landwirtsch. Jabrb., 18, 1839, 241; Migula, Syst. d. Bakt., 2, 1900.) From cheese. Winslow and Winslow (loc. cit., 233) regard this as a variant of Sarcina flara De Bary which has acquired certain fermentative powers.

guired certain formentative poeta-Sarcina candida Lindner. (Die Sarcina-Organismen der Gährungsgenerbe, Inaug. Diss, Berlin, 1888, 43; Abst. in Cent. f. Bakt., 4, 1888, 427.) From water reservoir of a brewery and from air in the vicinity of the brewery.

Sarcina canescens Stubenrath. (Stubenrath, in Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 143.) Stubenrath considered this a subspecies or variety of his Sarcina equi from which it differed only by its constant gray color on all culture media. Winslow and Winslow (toc. cit., 232) regard this as identical with Sarcina flat a De Bary.

Sarcina carnea Gruber. (Arb. bakt Inst Karlsruhe, 1, Heft 3, 1895, 278) From leaven.

Sarcina casei Migula. (Sarcina No VII, Adametz, Landwirtsch. Jahrb., 18,

1889, 242; Migula, Syst d. Bakt, 2, 1900, 239.) From cheese. Winslow and Winslow (loc. cit., 233) regard this species as a variant of Sareina flava De Bary which acquired certain fermentative powers.

Sarcina cascolytica Stark and Scheib. (Jour. Dairy Sci., 19, 1936, 212 ) butter.

Sarcina cervina Stubenroth (Stubenroth, in Lehmann and Neumann, Bakt. Diag., I Aufl., 2, 1896, 146 ) From the

stomach in a case of carcinoma

Sarcina citrea Winslow and Winslow (The Systematic Relationships of the Coccacceae, 1908, 231; not Sareina citrea Bergey et al., Manual, 1st cd , 1923, 74 ) This is the narce given by Winslow and Winslow to their Type 2, the intratereducing group of Sarcina.

Sarcina citrina Gruber (Arb bakt Inst. Karlsruhe, 1, Heft 3, 1895, 269) From leaven, Winslow and Winslow (loc. cit., 235) regard this species as identical with Sarcina lutea Schroeter

Sarcina conjunctuae Bergey et al (Sarcina citrea conjunctivae Verderame, Cent f. Bakt , I Abt., Orig , 59, 1911, 384; Bergey et al., Manual, 1st ed , 1923, 71.) From the conjunctiva Gramnegative.

Sarcina devorans Kern, (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1897, 502) From stomach contents of a sparrow (Passer montanus).

Sarcina equi Stubenrath. (Stubenrath, in Lehmann and Neumann, Bakt Diag., 1 Aufl., 2, 1896, 143.) Found frequently in the urine of borses. Very similar to Sarcina lutea according to Stubenrath, who names three subspecies or varieties: Sarcina Invido-lutescens, S. canescens and S. variabilis. Winslow and Winslow (loc cit., 232) regard this species as identical with Sarcina flava De Bary.

Sarcina erythromyza (Overbeck) Král. (Micrococcus erythromyza Overbeck, Nova Acta der Leop. Carol, 65, No. 7, 1891; Král, Verzeichnis der abzugebenden Bak.) For a description of this species, see Ziromermann, Die Bakterien unserer Trank- und Nutzwässer, Chemnitz, II. 1894. 70. From water. Produces a red pigment.

Sarcina fimentaria Lehmann and Neumann. (Eine bewegliche Sareine, Sames, Cent. f. Bakt , II Abt., 4, 1898, 661; Lebmann and Neumann, Bakt. Diag , 2 Aufl , 2, 1899, 146, Planosarcina samesit Migula, Syst. d. Bakt , 2, 1900, V and 278; Sarcina samesii Matzuschita, Bakt. Ding., Jena, 1902, 300.) From liquid manure. Exhibits active motility with many long flagella. Pribram (Klassifikation der Schizomyecten, 1933, 45) regards this organism as identical with Sareina ureae and Sarcina mobilis.

Sarcina flavescens Henrici. (Arb. bakt Inst. Karlsrube, 1, Heft 1, 1894, 91 ) From Swiss cheese Winslow and Winslow (loc cit, 232) regard this species as identical with Sarcina flava De Bary.

Sarcina fulva Stubenrath. Genus Sarcina, Munchen, 1897; see Lehmann and Neumann, Bakt Diag , 2 Aufl , 2, 1809, 143.) Isolated many times from stomach contents and once from preputial smegma. Similar to Sarcına pulmonum.

Sarcina fusca Gruber (Arb. bakt. Inst. Karlsruhe, 1, Heft 3, 1895, 282.) From flour

Sarcina fuscescens De Bary (Vorlesungen über Bakterien, 2 Aufl , 1887, 181 and Botan Centrolb., 1887, 34 Reduced to a synonym of Sarcing ventriculi Goodsir by Migula, Syst. d. Bakt , 2. 1900, 259) From the contents of the stomacb.

Sarcing gasoformans Gruber, (Arb. bakt Inst Karlsruhe, 1, Heft 3, 1895, 270) From leaven Young cultures produce considerable gas

Sarcina gigantea Kern (Arb bakt. Inst. Karlsruhe, 1, Heft 4, 1897, 508) From stomach contents of the starling (Sturnus tulgaris). The diameter of a cell is 2 05 to 2.1 microns. Winslow and Winslow (loc cit., 232) regard this species as identical with Sarcina flava De Bary.

Sarcina gigantea Petter (Proc. Kon.

Akad. Wet. Amsterdam, \$4, 1931, 1417; Thesis, Utrecht, 1932; Compt. rend. Acad. Sci , Paris, 196, 1933, 300.) salted herring. Halophilic.

Sarcina hamaguchiae Saito. (Cent. f. Bakt., II Abt., 17, 1906, 155.) From

sov bean mash.

Sarcina incana Gruber (loc. cit., 248). From leaven.

Sarcina incarnata Gruber. (Loc. cit... 279; Rhodococcus incarnatus Winslaw and Rogers, Jour Inf. Dis., 3, 1906, 545.) From leaven. Produces pink pigment.

Sarcina intermedia Gruber (Loc. cit., 277), From leaven, Winslow Winslow (loc. cit., 235) regard this species as identical with Sarcina lulea Schroeter.

Sarcina intestinalis Zopf. (Die Spaltpilze, 3 Aufl., 1835, 55.) From the intestines of poultry

Sarcina lactea Gruber. (Loc. cit., 251; not Sarcina lactea Bergey et al., Manual, 1st ed., 1923, 73.) From leaven.

Sarcina lactis Chester. (No 45, Conn. Storrs Agr. Exp Sta. Rept , 1894, 79; Chester, Man. Determ. Bact., 1901, 111.) From fermented milk (matzoon). Winslow and Winslow (loc. cit, 232) regard this species as identical with Sarcina flava De Bary.

Sarcina lactis acidi Conn, Esten and Stocking. (Storrs Agr. Evp. Sta. Ann. Rept., 1907, 125.) From milk.

Sarcina lactis albus Conn, Esten and Stocking (loc. cit., 121). From milk.

Sarcina lactis aurantiace Conn, Esten and Stocking (loc. cit., 125). From milk.

Sarcina luciis lutea Conn, Esten and Stocking (loc, cit, 124). From milk.

Sarcina lembkei Migula (No. 21, Lembke, Areli. f. Hyg., 26, 1896, 316; Migula, Syst. d. Bakt., 2, 1900, 211.) From the intestine. Winslow and Winslow (loc. cit., 232) regard this species as identical with Sarcina flava De Bary.

Sarcina liquefaciens Frankland and Frankland. (Phil. Trans. Royal Soc.

London, 178, B, 1888, 267.) From dust. Also found in cheese by Henrici (Arb. bakt. Inst. Karlsruhe, 1, Heft I, 1891. 95). Winslow and Winslow (loc. ett., 232) regard this species as identical with Sarcina flava De Bary.

Sarcina livida Gruber (loc, cit, 207). From leaven. Winslow and Winslow (loc. cit., 235) regard this species as identical with Sarcina lutea Schroeter Sarcina livido-lutescens Stubenrath. (Stubenrath, in Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 143; Sarrina lutescens Chester, Man. Determ. Bact., 1901, 112.) From stools in a case of enteritis. Stubenrath regards this as a subspecies or variety of his Sarcina equi.

Sarcina loewenbergii Macé. sarcine pathogène, Loewenberg, Ann. Inst. Past., 18, 1899, 358; Mace, Traité Pratique de Bact., 4th cd., 1901, 461.) From the nasal cavity in a case of ozens. Probably a strongly slime-forming variety of Sarcina letragena, according to Lehmann and Neumann, Bakt. Diag, 5 Aufl., 2, 1912, 206. Also see Galh-Valerio, Cent. f. Bakt., I Abt., Orig., 47, 1908, 177, for discussion.

Sarcina luteola Gruber (loc. cit, 265). From leaven. Winslow and Winslow (loc. cit., 235) regard this species 83 identical with Surcina lutea Schroeter Sarcina marginuta Gruber (loc. cd.,

268). From leaven. Winslow and Winslow (loc. cit., 235) regard this as identical with Sarcina lutea Schroeter.

Sarcina meliflara Gruber (loc. cit, 272). From flour. Winslow and Winslow (loc. cit., 235) consider this identical with Sarcina lutea Schroeter.

Sarcina minuta De Bary. (Vorlesungen über Bakterien, 1 Aufl., 1885; Eng. trans., 2nd ed., 1887, 117 and 185.)

Sarcina mirabilis Kern. (Arb. bakt Inst. Karlsruhe, 1, Heft 4, 1897, 506) From intestine of the yellow-hammer (Emberiza citrinella) and a dove (Columba oenas). Winslow and Winslow (loc. cit., 232) consider this species identical with Sarcina flava De Bary.



Bakt., II Abt., 61, 1925, 495; Pribram, Klassifikation der Schizomyceten, 1933, 45.) Lives symbiotically with cockroaches.

Sarcina thermodurica Wainess and Parfitt. (Jour. Bact., 40, 1940, 157.) From milking machines and other dairy farm utensils. Resists pasteurization temperatures

Sarcina thermophila Bargagli-Petrucci. (Nuov. Giorn Bot Ital., 22, 1913; Abst.) in Cent f. Bakt., II Abt., 45, 1915, 294.) From the borax-yielding waters of Tuscany, Grows at temperatures up to 75°C.

Sareina urinae Welcker (Sareina renis Hepworth, Microscop Jour., 6, 1857, 1; Welcker, in Henle and Pfeffer, Ztschr f. rat Med, 3 Ser, 6, 1859, 199; Merismopedia urinae Rabenhorst, Flor. europ. algarum. 2, 1865, 59.) Observed in the bladder See below, Sareina welcker:

Sareina variabilis Stubemiath (Stubenrath, in Lehmann and Neumann, Bakt Diag, 1 Aufl. 2, 1896, 143) From gastric contents May be considered a subspecies of Sareina equi Stubenrath Winslow and Winslow (dec cit., 232) regard this as identical with Sarcina flava De Bary.

Sarcina variegata Pansini. (Arch f. path. Anat., 122, 1890, 450.) Found in sputum from cases of influenza.

Sarcina relutina Gruber (loc. cit, 275). From leaven. Winslow and Winslow (loc. cit., 235) consider this species identical with Sarcina lutea Schroeter Sarcina vermicularis Gruber (loc. cit,

Sarcina vermicularis Gruber (lo 253). From wheat flour.

Sareina vermiformis Gruber (loc. cit., 266). From leaven. Winslow and Winslow (loc cit., 235) consider this species identical with Sareina lutea Schroeter. Sareina viridis flarescens Rosenthal (Inaug. Diss., Erlangen, 1893; Abst. in Cent. f. Bakt., 16, 1894, 1024.) From the oral cavity.

Sarcina welckeri Rossmann. (Rossman, Ueber Urinsarcina, Flora, 49, 1857, 641; Merismopedia welckeri Rabenhorst, Flora curopaea, Alg. II, 1865, 58) From the urinary bladder

Urosarcina dimorpha Beijerinch. (Cent. f. Bakt., II Abt., 7, 1901, 53) Reported to form spores. Non-motile. From garden earth.



- Ghromogenesis best seen on Löffler's serum.
  - a. Acid from fructose.

    - bb. No acid from sucrose.
- Neisseria perflava.Neisseria flava.
- aa. No acid from fructose.
  - b. Acid from glucose.
- 7. Neisseria subflava.
- bb. No acid from glucose.
  - A. Gas produced from peptone broth.
  - a. Oas produced from perione pro
  - B. No gas produced.

II. Anaerobes.

- 1. Odor of rancid butter.
- 2. No rancid odor.

- 8. Neisseria flavescens.
- 9. Neisseria discoides.
- 10. Neisseria reniformis.
- 11. Neisscria orbiculata.

1. Neisserla gonorrhoeae Trevisan. (Micrococcus der Gonorrhoe, Neisser, Vorl. Mitteil, Cent. f. Medicinische Wissenschaft, 17, 1879, 497; Trevisan, Atti della Accademia Fisio-Medico-Statistica in Milano, Ser 4, 8, 1885, 105.) From Greek, gonorrhoea flux of semen; M.L. genitive of gonorrhoea

Synonyms: Gonococcus, Diplococcus der Gonorrhoe, Bumm, Der Mikroorganismen der gonorrhoischen Schleimhauterkmnkung, Weisbaden, 1885, 16; Merssmopedia gonorrhoeae Zopf, Die Spaltpilze, 1885, 51; Micrococcus gonorrhoeae Flego; Die Mikroorganismen, 1886, 156; Micrococcus gonococcus Schroeter, in Cohn, Kryptog Flora v. Schlesien, 5, I, 1886, 147, Diplococcus gonorrhoeae Lehmann and Neumann, Bakt Diag, 1 Aufl., 2, 1896, 150, Micrococcus gonorrhoeae Lehmann and Neumann, told, 4 Aufl., 2, 1907, 212.

Spheres: 0 6 to 1.0 meron, occurring singly and in pairs, the sides flattened where they are in contact. Gramnegative

Grows only on media with the addition of body fluids (blood, ascites, etc.), or other specially prepared media.

Colonies are small, transparent, even-

tually (2 to 4 days) developing a lobate margin, grayish-white with a pearly opalescence by transmitted light. Larger colonies on special media.

Acid from glucose. No acid from maltose, fructose, sucrose and mannitel Optimum temperature 37°C. No

growth below 25° or above 40°C.

Aerobic to facultative anacrobic.

Many strains develop more readily with increased CO<sub>2</sub> tension.

Common name : Gonococcus.

Source: Originally found in purulent venezeal discharges. Also found is blood, conjunctiva, joints and cerebrospinal fluid.

Habitat: The cause of gonorrhoca and other infections of man. Not found in other animals.

2. Nelsserla meningitidis (Albrecht and Ghon) Holland. (Diplokokus nutzellularıs meningitidis Weichselbaum, Fortselır. d. Med., 6, 1887, 583; Neistera weichselbaumii Trevisan, I generi el specie delle Batteriacec, 1889, 32; not Diplococcus intracellularis Jacger, Zischr. f. Hyg., 19, 1895, 333; not Tetracceus intracellularis Jacger, bild., 363; pot Streptococcus untracellularis Lehmann

1896, 132; Micrococcus intracellularis Migula, Syst. d Bakt., 2, 1900, 189, Micrococcus meningococcus cerebrospinalis Albrecht and Ghon, Wiener Llin Wochnschr., 14, 1901, 988, not Streptococcus weichselbaumit Chester, Man. Determ. Bact., 1901, 64, not Meningococcus intracellularis Jacger, Cent. 1 Bakt., I Abt., Orig., 55, 1903, 23, Micrococcus meningitidis Albrecht and Ghon, Cent, f. Bakt., I Abt , Orig , 55, 1903, 498; Diplococcus intracellularis Weichselbaum, Cent. f. Bakt., I Abt , Orig , 35, 1903, 511; Micrococcus intracellularis meningitidis de Bettencourt and Irança, Ztschr. f. Hyg., 46, 1901, 464, Diplococcus meningitidis, ibid., 495; Holland, Jour Bact., 5, 1920, 224; Newscria intracel lularis meningitidis Holland, ibid , 221, Neisseria intracellularis Ilolland, ibid , 221, see also Elser and Huntoon, Jour Med. Res , 20 (N. S. 15), 1909, 371 and Murray, Med. Rcs. Council, London, Special Report Series No 124, 1929 for detailed studies of the group ) From Greek, mening, meninges, a membrane, a membrane covering the brain; M L genitive of meningitis, an inflammation ol the meninges.

and Neumann, Bakt. Diag., 1 Aufl., 2,

The binomial, Neisseria intracellularis, used in previous editions of the Manual has proved confusing because the names Micrococcus intracellularis, Diplococcus intracellularis and Streptococcus intracellularis, have been used loosely for unrelated organisms. Neisseria ueichsel baumii has been so rarely and loosely used that any attempt to introduce st now is inadvisable despite rights of priority. The equally available name, Neisseria meningitidis, has therefore been adopted to avoid lurther confusion It has the obvious advantage of association with the common name, meningococcus, which has been so frequently used in the literature.

In 1898, Councilman, Mallory and Wright (Epidemic Cerebrospinal Memngits and its Relation to Other Forms of Meningitis, Boston, 1898) definitely established the Gram-negative coccus as the cause of epidemic meningitis and clanified the confusion created because Jaeger regarded the coccus that he isolated (see Diplococcus crassus von Langelsheim) as identical with Nesseria meningitidis.

Spheres: 0 6 to 0 8 micron in diameter, occasionally larger, occurring singly, in pairs with adjacent sides flattened, or occasionally in tetmds. Gram-negative.

Good growth is obtained on media contuning blood, blood serum and other carrelment fluids with added glucose, Best growth on special media

Blood agar plates are generally eraployed to isolate the organism. The colonies are small, slightly convex, transparent, glistening Colonies large on special media.

Older cultures may show growth on neutral agar or glucose agar, properly prepared Frequent transplantation is necessary to keep the organism alive in recently isolated strains, older strains survive lor one mouth or longer at 37°C and for years on special media

Acid from glucose and maltose No acid from fructose, sucrose and mannitol. Nitrites not produced from mirates (Branlam)

Optimum temperature 37°C No crowth at 22° or at 40°C

Aerobic, no growth anaerobically Common name. Meningococcus

Source: Originally found in cerebrospinal fluid Also found in nasopharynx, blood, conjunctiva, pus from joints, petechiae in skin, etc

Habitat Nasopharynx ol man, not lound in other animals Cause of epidemic cerebrospinal fever (meningitis).

Four main varieties or types of Netsseria meningitidis have been differentiated by Gordon and Murray (Jour. Roy Army Med. Corps, 25 (2), 1915, 423) and by others on the basis of ogglutination reactions with minune serums

3. Neisserla catarrhalis (Frosch and Kolle) Holland. (Micrococcus catarrhalis Frosch and Kolle, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 154; Diplococcus pharyngis communis von Lingelsheim, Klin, Jahrb., 15, 1906, 408; Holland, Jour Baet., 5, 1920, 224.) From Greek, catarrh, a running down.

Spheres: 0 6 to 0.8 mieron in diameter. occurring singly or in pairs with adjacent sides flattened, occasionally in fours.

Gram-negative.

well at 22°C.

Agar eolonies: Small, eircular, grayish white to dirty white, with crose margins Broth: Turbid, often with slight pel-

licle. No acid from any of the carbohy drates. Optimum temperature 37°C. Grows

Aerobie, facultativo.

Source: Nasopharyny, saliva and respiratory tract.

Habitat : Human mucous membrane of the respiratory tract. Often associated with other organisms in inflammations of the mucous membrane

NOTE: Topley and Wilson (Prin. of Bact., 1931, 349) state that Neisseria pharyngis cinerea (Micrococcus pharyngis cinereus von Lingelsheim, Klin Jahrb., 15, 1906, 373) resembles Neisseria catarrhalis so closely that it should probably be regarded as a variety of this species.

4. Neisserla sicea (von Lingelsheim) Bergey et al. (Diplococcus pharyngis siccus von Lingelsheim, Klin Jahrb., 15, 1906, 409; Diplococcus siccus von Lingelsheim, Ztschr f Hyg., 59, 1938, 476; Micrococcus pharyngis siccus Kutscher. in Kolle and Wassermann, Handb. d. Path Mikroorganismen, 2 Aufl., 4, 1912, 603; Micrococcus pharungis-siccus Holland, Jour of Bact., 5, 1920, 224; Newsscria pharyngis-sicci (sic) Holland, ibid.; Bergey et al., Manual, 1st ed., 1923, 43) From Latin, sicca, dry.

Spheres: 0 6 to 0 8 micron in diameter. occurring singly and in pairs with adjacent sides flattened Gram-negative.

Blood ngar colonies: Grayish, somewhat dry, crumbling when an effort is made to remove them.

Ascitic agar colonies: Small, very firm and adherent to medium, becoming corrugated on the surface.

The organisms precipitate spontaneously when suspended in normal salt solution.

Acid from glucose, fruetose, maltose and sucrose. No acid from mannitol Optimum temperature 37°C. Grows

at 22°C. Aerobic, facultative.

Source: Nasopharynx, saliva and spu-

Habitat: Mucous membrane of the respiratory tract of man.

5. Nelsserla perflava Bergey et al (Chromogenic group I, Elser and Huntoon, Jour. Med. Res., 20 (N. S. 15), 1909, 415; Bergey et al., Manual, 1st ed , 1923, 43.) From Latin per, very and flavus, yellow.

Spheres: 0.6 to 0.8 micron, occurring singly and in pairs with adjacent sides

flattened. Gram-negative.

Glucose agar colonies: Small, circular, slightly raised, greenish gray by reflected light, and greenish yellow and semiopaque by transmitted light. The surface is smooth, glistening. The growth is adherent to the medium. Chromogenesis best seen on Löffler's blood serum medium.

Ascitic agar colonies: Like those on

glucose agar.

Acid from glucose, maltose, fructose, sucrose and mannitol.

Optimum temperature 37°C. Grows at 22°C.

Aerobic, facultative.

Source: Nasopharyny, saliva and spu-

Habitat: Mucous membrane of respiratory tract of man.

 Nelsseria flava Bergey et al. (Diplococcus pharyngis flavus I and possibly Diplococus pharyngis flavus II, von Lingelsheim, Klim Jahrb., 15, 1906, 499. Deplococcus flavus I and possibly Deplococcus flavus I and possibly Deplococcus flavus I and possibly Micrococcus pharyngis flavus I and possibly Micrococcus pharyngis flavus II, Lehmann and Neumann, Bakt. Diag., 7 Aufl. 2, 1927, 259; Chromogenie group II, Elser and Huntoon, Jour. Med. Res., 20 (N S 15), 1909, 415; Bergey et al., Mannal, lat ed. 1923, 43) From Latin flaus, yellow.

Spheres: 0.5 to 0.8 micron, occurring singly and in pairs with adjacent sides

flattened, Gram-negative

Glucoso agar colonies: Small, circular, silightly raised, greenish, rgay by reflected light and greenish, yellow by transmitted light. Growth not adherent to medium Surface colony is smooth with numerous, rather coarse crumbs in center Margin entire, or rarely slightly irregular Ghromogenesis best seen on Loffler's blood serum medium.

Ascitic agar colonies: Like those on

glucose agar.

Acid from glucose, fructose and maltoso. No acid from sucrose or mannital

Optimum temperature 37°C. Gross

at 22°G. Source: Nasopharynx, cerebro-spinal

fluid in cases of meningitis (very rare).

Habitat: Mucous membrane of respiratory tract.

7. Neisseria subflava Bergey et al (Chromogenie group III, Elser and Huntoon, Jour. Med. Research, 20 (N.S 15), 1902, 415, Bergey et al., Manual, 1st ed., 1923, 44) From Latin sub, less and flavis, yellow.

Spheres: 0 6 to 0 8 micron, occurring singly and in pairs with adjacent sides flattened. Gram-negative

Glucose agar colonies Small, slightly raised, pale greenish-yellow, especially on primary culture.

Acid from glucose and maltose No acid from fructose, sucrose or mannitol. Agglutimates in normal rabbit serum.

Optiroum temperature 37°C. Little or no growth at 22°C.

Aerobic, facultative

Easily confused with Neisseria meningitidis.

Source: Nasopharyny.

Source Nasopnaryny

Habitat. Mucous membrane of the respiratory tract of man

8 Nelsserla flavescens Branham (U S Public Health Service, Pub. Health Repts., 45, 1930, 845) From Latin flatescens, becoming yellow.

Biscutt-shaped cocci occurring in flattened pairs. Giant forms common.

Gram-negative.

Glucose agar. Poor growth Blood agar: Good growth, colonies less moist than those of the meningococcus. Golden yellow pigment. Greenish-yellow on Loffler's blood scrum medium.

Semisolid agar. Good growth

No acid from any of the carbohydrates

Optimum temperature 37°G.

Acrobic, facultative

Serologically homogeneous group
Source Cerebro-spinal fluid in cases

of meningitis.

Habitat Probably mucous membrono of respiratory tmet of man.

Norn: Wilson and Smith (Jour. Path and Bact, 31, 1923, 597) do not regard differences in sugar ferimentations, chromogeness, appearance of colonies, et sufficiently constant to warrant the separation of the species Nesseria catarrhatis, N facto, N cincrea, N mucosa and N sieca. They recommend that all be grouped under a single species known as Nesseria pharyngis (Diplococcus pharyngis).

 Neisserla discoides Prévot (Ann. Sci Nat., Sér Bot., 15, 1933, 106)
 From Greek, discoeides, discus shaped;
 Latinadj, disk-shaped.

Spheres: 0.6 to 0.7 micron, occurring in pairs or tetrads Gram-negative.

Gelatin: No liquefaction.

Deep agar colonies: Lenticular, up to 1 mm in diameter Grows in a narrow disk about 1 cm below the surface. Gas produced

Broth Turbid. Fine granular precipitate. Slight rancid odor and inflammable, explosive gas produced.

Peptone water: Gas produced Indole not formed.

No action on milk.

Congulated proteins not digested. Carbohydrates not attacked.

Hydrogen sulfide not produced.

Neutral red glucose broth: Becomes pink, but no further change.

Optimum pH 70 to 80.

Temperature relations Optimum 37°C. No growth at 28°C. Killed in half an hour at 60°G.

Non-pathogenie

Strict anaerobe.

Distinctive characters Colonies grow in narrow zone 1 cm below the surface of an agar stab; gas produced from pep-

Source: Isolated from bronchial mucus. respiratory system, dental and tonsillary focal infections.

Habitat: Buccal cavity (human) and probably also in other warm-blooded animals.

10. Nelsseria reniformis (Cottet) Prévot. (Diplococcus reniformis Cottet, Compt rend. Soc Biol , 52, 1900, 421; Micrococcus reniformis Oliver and Wherry, Jour. Inf. Dis., 28, 1921, 341; Prévot, Ann. Sci. Nat , Sér Bot., 15, 1933, 102.) From Latin, ren (renes), kidney; -formis, form, i.e. kidney-shaped.

Spheres: 0.8 to 1.0 micron, bean-shaped, occurring in pairs Gram-negative

Gelatin: No liquefaction.

Deep agar colonies · Appear in 24 to 48 hours; at first punctiform, then lenticular; small, 03 to 0.5 mm. No gas produced.

Agar slant : Minute, bluish-white, dewdrop colonies.

Broth: Turbid in 24 hours; flocculent precipitate rapidly formed, clearing the medium. No gas produced, but a rancid odor is present.

Peptone water: Very meagre growth. Traces of indole.

Milk: Unchanged.

Congulated proteins not digested.

Slight amount of acid from glucose by one strain only.

Optimum pH 7.0. Limits of pH 60

Temperature relations: Optimum 37°C. No growth at 22°C. Killed in half an hour at 60°C, or in an hour at 56°C Pathogenic.

Strict aggerobe.

Distinctive character: Odor of rancid butter.

Source: Isolated in several cases from suppurations of the urino-genital system Habitat: Presumably in bodies of warm-blooded animals.

 Neisserla orbiculata Prévot. (Dip. lococcus orbiculus Tissier, Ann. Inst. Past., 22, 1908, 204; Prévot, Ann. Sci Nat., Sér Bot., 15, 1933, 109.) From Latin, orbiculatus, having the form of an orb or sphere.

Spheres: 1.5 to 2.0 microns, occurring in pairs. Gram-negative.

Gelatin: No growth at 22°C.

Deep agar colonies: After 36 to 48 hours, large, lenticular, very regular, whitish almost transparent. Gas not produced Broth: Turbid. Sediment.

Milk: No coagulation.

Egg white not attacked. Proteoses attacked without formation

Acid from glucose. Acid produced feebly from lactose. No acid from sa-

Temperature relations : Optimum 37°C.

No growth at 22°C. Killed at 60°C.

Non-pathogenic. Strict angerobe.

Distinctive characters: Large size; no gas production

Source: Isolated from feces of young children.

Habitat: Intestinal canal Not common.

Appendix I: Additional species have been placed in this genus as given below Some are undoubtedly identical with previously described species, while some may belong in other genera

Diplococcus crassus von Langelsheim (Diplococcus intracellularis Jueger, Zlesh, I. Ilyg., 19, 1833, 333, Tetracoccus intracellularis, told, 318, von Langelsheim, Zischir, I. Ilyg., 59, 1903, 467, Micrococcus crassus Lehmann and Neumann, Baht, Ding., 7 Aufl., 2, 1927, 259). Commonly found in nasopharyngeal secretions, also in the cerebrospinal fluid of suspected cases of meningitis. Also known as Jacger's coccus of as Jacgersher Modifikation der Meningococcus.

Diplococcus mucosus von Lingelsheim (von Lingelsheim, Klin, Jahrb , 15, 1906, 373, and Ztschr. f. Hyg , 59, 1908, 457, Neisseria mucosa Murray, in Manual, 5th ed., 1939, 233, not Strentococcus mucesus Howard and Perkins, Jour Med Res, 6, (N S 1), 1901, 174, not Pneumococcus mucosus Park and Williams, Jour Exp. Med., 7, 1905, 411.) From nasal secretions This Gram-negative coccus is said to show similarity to the meningococcus and to be like the diplococcus found by Weichselbaum and Ghon (Weiner Klin Wehnschr , No 21, 1905) in nasal secretions of a healthy person. Clearly it is different from the Gram positive, mucord type of pneumococcus which is described by Binaghi (Cent f. Bakt, I Abt., 23, 1897, 273), Howard and Perkins (Jour Med. Res , 6, 1901, 174), Park and Williams (Jour. Exp. Med., 7, 1905, 411) and others

Micrococcus pharyngis cinereus von Lingelsheim. (Klin. Jahrb, 15, 1906, 373; Mucrococcus cinereus v Lingelsheim, Ztschr. f. Hyg., 59, 1908, 456, Neisseria cinerea Murray, in Manual, 5th ed., 1939, 283 ) From mucous membrane of nose and threat.

Nesseria arthritica (Costa) Hauduroy et al (Micrococcus arthritica Costa, Comp rend. Soc. Biol., Paris, 68, 1920, 933, Handuroy, Ehringer, Urbain, Guillott and Magrou, Dictionaire des Bactéries Pathogènes, Paris, 1937, 296) Isolated from a case of luman arthritis Nesseria edigioni (sic) Trevisan.

Neisseria edigloni (sic) Trevisan. (Diplococas scarlatinas sanguinis Jamieson and Edington, Brit. Med. Jour., 1, 1887, 1265, Trevisan, I generi e le specie delle Batteriacce, 1889, 32) From a scarlet (ever patient

Nesseria fulta De Bord. (Jour Bact., 33, 1989, 119, Iowa State Coll. Jour Sci., 16, 1912, 471) From conjunctivitis and vacantis

Nessera gibbons Hauduroy et al. (Gram-negative coccus, Gibbons, Jour. Inf Dis., 45, 1929, 259; Haudurny et al., Diet d Baet Path., 1937, 300) Isolated from skin abscesses in rabbits and cuinca pics.

Neisseria giganica Do Bord (Jour. Baet, 38, 1939, 119; Iowa Stato Coll. Jour Sci., 16, 1942, 472) From a normal vagina

Neisseria luciliarum Brown (Amer. Mus Novit, No 251, 1927, 3) A motile, Gram-negative diplococcus that probably should be placed in the genus Micrococcus From a dead fly, Lucilia sericata killed by Bacillus lutrae.

Nesseria pseudocatarrhalis Huntoon. (Jour Bact, 27, 1934, 193) Like Nesseria catarrhalis, shows no action on carbohydrates but is culturally more like Nesseria meningitatis and forms bomogeneous suspensions in a salt solution. From masophiarynx

Neisseria rebellis Trevisan. (Micrococcus in Trachoma folliculare, Kucharksky, 1887, Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 32) From trachoma

Neisseria renezuelensis Hauduroy et al (Riguez, Gaceta Med. de Caracas, June 30, 1935; Pedro del Corral, Rev. de Med. y Cir. de la Clinica Maeneay, April, 1935; Hauduroy et al., Diet. d. Baet. Pnth., 1937, 308.) Found in localized epidemics of cerebrospinal meningitis in Venezuela.

#### Genus II. Vellionella Précot.\*

(Ann. Sci. Nat., Sér. Bot, 15, 1933, 118.) Named for A. Veillou, the French bacteriologist, who isolated the type species.

Small, Gram-negative cocci averaging 0.3 micron. Occur in masses, rarely in pairs or short chains. Cells undifferentiated. United by an interstitial substance of ectoplasmic nature. The known species are anaerobic. Good growth on standard culture media. Biochemical activity pronounced. Harmless parasites in mouth and intestine of man and animals.

The type species is Veillonella parcula (Veillon and Zuber) Prévot.

#### Key to the species of genus Velllonella.

I. Acid and gas from glucose. Weakly hemolytic.

1. Veillonella parrula.

- Carbohydrates not attacked. Gas produced from peptone broth. Nonhemolytic.
- Veillonella pervula (Veillon and Zuber) Prévot (Staphylococcus parvulus Veillon and Zuber, Arch. méd Exp., 1803, 512, Micrococcus parvulus Bergey et al., Manual, 3rd ed., 1930, 92, Prévot, Ann. Sei Nat., Sér Bot., 16, 1933, 119)
   From Latin, parvulus, very small.

Description from Prévot (loc ett.). Very small spheres. 0 2 to 0.1 micron, occurring in masses, occasionally in very

short chains Gmm-negative Gelatin: No liquefaction

Semisolid agar (Veillon) colonies: At first punctiform, becoming lenticular, reaching a diameter of 2 mm Gas bubbles.

Blood agar colonies Usually surrounded by a clear halo; weakly hemolytic. Agar slant Transparent, bluish, min-

ute colonies.

Peptone broth: Turbid with fine sedi-

ment.
Glucose broth: Turbid, Faintly fetid

odor. Gas produced contains GO<sub>2</sub>, II<sub>2</sub> and II<sub>2</sub>S.

Broth serum: Very abundant, rapid

Broth serum: Very abundant, rapi growth.

# 2. Veillonella gazogenes.

Milk: No acid. Not congulated. Some strains produce gas.

Small amount of indole formed. Nitrites produced from nitrates. Acid and gas from glucose. Slight amount of acid from fructose, grlactose and sucrose. Some strains feebly attack

mannical, maltose and innlin.
Congulated protein not attacked.
Ammonia not produced.

Hydrogen sulfide produced. Optimum pH 6.5 to 8.0. Temperature relations: Optimum 37°C.

Temperature relations: Optimizations of Grows feebly at 22°G. Killed in one hour at 55°C.

Strict anaerobe.

Distinctive characters: Fermentation of polypeptids to produce hydrogen carbon dioxide, hydrogen sulfide and indole; fermentation of sugars; hemolysis of blood; production of nitrites from nitrintes.

Source: Isolated by Veillon and Zuber from appendices, buccal cavities and lungs. Of the 13 strains studied by Prévot, 3 were isolated from pulmonary gangrene, one from an appendix, one

<sup>\*</sup>Revised by Prof. E. G. D. Murray, McGill University, Montreal, P. Q. Canada, June, 1938. Descriptions reviewed by Dr. Ivan G. Hafl, New York City, January, 1944.

from alveolar pyorrhea, 5 from anniotic fluid, 2 from abscesses and pulmonary congestion and one from the buccal cavity of a normal rabbit. Found in suppurative lesions or pus 1t may occasionally be pathogenic and invade the tissues, causing suppurations, alone or to association with other pyogenic organisms.

Habitat: Normally a harmless parasite found in natural cavities of man and animals, especially the mouth and digestive tract.

la. Veillonella parvula var minima Prévot. (Staphylococcus minimus Gio-elli, Boll. R. Accad. Med. di Genova, 1907; Abst. in Cent. f Bakt. 1 Abt., Ref., 42, 1903-90, 952; Mierococcus minimus Bergey et al., Manual, 1st ed., 1923, 69; Prévot. Ann Ser. Nat., Ser. Bot., 15, 1933, 125.) From Latin, minimus, smallest.

Differs from Veillonella parvula only in its slightly smaller size (0 2 to 3 micron). Growth only at 37°C No growth ongolatin. Growth on the wall of the culture tube in fine flakes, not clouding the medium, and no plasmoly sis in a 5 per cent saft solution.

Source: Isolated from a periuterine

1b. Veillonella parvula var brankamii Prévot. (Ancerbic mercoccus, Branham, Jour Inf. Dis, 41, 1927, 203; shd, 42, 1928, 230, Micrococcus brankamii Bersey et al., Manual, 3rd ed., 1930, 92, Prévot, Ann. Sci. Nat., Sér Bot., 16, 1933, 120) Named for Dr. Sana E. Brankam, of the National Institute of Health, Washington, D. C.

Serologically distinct from Veillbnella parvula. One strain liquefied gelatin slowly.

Source: Isolated from nasal washings in two cases of influenza

1c. Peillonella parvula var. thomsonsi Prévot. (Anaerobic diplococcus, Thomson, Jour. Trop. Med and Hyg., 26, 1923, 227 and Ann Pickett-Thoruson Res Lab., 1, 1934-25, 105 and 164, Prévot, Ann. Sci. Nat , Sér Bot , 16, 1933, 126; Micrococcus thomson: Handuroy et al., Diet d. Baet Path , 1937, 283 ) Named for Dr. David Thomson of London, England

Differs but slightly from Veillonella parvula in that it requires some accessory factor of growth found in serum or similar body fluids, testicular agar and the like.

Source · Found in the throat in measles and scarlet fever

2 Veilionella gazogenes (Hall and Hownt) Murray (Micrococcus gazogenes alcalectens anacrobus Lewkowics, Arch Néd Exp. 18, 1901, 633, Micrococcus gazogenes Hall and Howitt, Jour Inf. Dis., 37, 1925, 112, not Micrococcus gazogenes Choukévich, Ann Inst Pasteur, 25, 1911, 309, Veillonella alcalescens Prévot, Ann. Sci Nat, Sér. Bot., 16, 1933, 127; Micrococcus alcalescens Hauduroy et al., Dict d Bact Path, 1937, 274; Murray, in Manual, 5thed, 1939, 287) From Latin, the gas-

The species name gategeness a given by Hall and Hoavit is well established in the literature for this organism. It is valid under the rules when the organism is placed in a new genus (Veillonita) in spite of the earlier use of Micrococcus gategenes by Choukévitch for a different organism.

Spheres 03 to 07 micron, average 04 micron, occurring in irregular masses, rarely in pairs, short chains or singly. Gram-negative.

Gelatin No liquefaction.

producing Veillonella

Deep agar colonies At first punctiform, becoming lenticular. Gas bubbles appear after 16 to 18 hours.

Blood agar plate. Minute colonies. Non hemolytic. Several strains show greenish colonies.

Peptone broth: Gas produced Broth becomes slightly alkaline.

Indole not formed.

Milk: Gas, but no acid. No coagulation.

Ammonia and hydrogen produced in small amounts.

Egg-white and coagulated serum not attacked.

Hydrogen sulfide not produced.

Carbohydrates not attacked.

Nitrites not produced from nitrates.

Slowly plasmolysed in 5 per cent NaCl solution.

Optimum pH 6.0 to 80 Will grow in broth of pH 5.5.

Temperature relations: Optimum 37°C. Some strains grow at 22°C. Killed at 56°C in one hour, or at 65°C in a half aour, or at 80°C in 10 minutes.

Non-pathogenic (Lewkowicz's strains). Two strains (Prévot) pathogenic for rabbits.

Strict anaerobe.

Distinctive characters: Differs from Veillonella parvula in that it does not ferment sugars, does not produce II,S nor indole, is not hemolytic, does not produce nitrites from nitrates, and does not develop fetul dodrs.

Source: Isolated (Lewkowicz) from mouth of a healthy infant. Twenty-lour strains (Itali and Howitt) from human salva Fifteen strains (Prévot) one from alveolar pyerrhea, one from pulmonary gangene, 5 from tonsils, one from appendix, 2 from measles, 3 from scarlet fever, and 2 from normal guinea pigs and rabbits.

Habitat: Prevalent in saliva of man and animals.

2a. Veillonella gazogenes var gingiralis Murray. (Kleiner Micrococcus, Ozaki, Cent. f. Bakt, I. Abt., Orig., 82, 1912, 83; Micrococcus gingiralis Bergey et al., Manual, 1st ed. 1923, 63; Veillonella daelessens var, gingiralis Prévot, Ann. Sci. Nat., \$6r. Bot., 15, 1933, 133; Murray in Manual, 5th ed., 1939, 288.) From Latin, pertaining to the gums. Differs from Veillonella gazogenes by its ability to grow at 22°C, and by the fact that glucose favors its growth although this carbohydrate is not fermented.

Source: Oral cavity and (Prévot) two strains from the intestine.

2b. Veillonella gazagenes var. munutssima Murray. (Micrococcus minutssimus Oliver and Wherry, Jour. Inf. Dis. 29, 1921, 312; Teillonella alcalescens var munutissima Prévot, Ann. Sci. Nat., Sér. Bot., 15, 1933, 134; Murray, in Manual, 5th ed., 1939, 253.) From Latin, very tiny.

Differs from Veillonella gazogenes only in that the usual carbohydrates favor growth and that the gas formed is not absorbed by sodium hydrovide and

is not inflammable.

Non-pathogenic for rabbits, guinea pigs or white mice (Oliver and Wherry).

Source: Two strains isolated from a mixed infection in aphthous ulcers of the gingival and buccal mucosa of a case of postpoliomyclitic paralysis.

2c. Veillonella gazogenes var. 1919/10/
Murray. (Syzygiococus scarlatinae Hettberg, Cent. f. Bakt., I Abt., Ref., 39,
1928, 575; Micrococus syzygios scarlatinae Herzberg, Cent. f. Bakt., I Abt.
Orig., 111, 1929, 373; Micrococus syzygios
Bergey et al., Manual, 3rd ed., 1939, 52;
Veillonella adcalescens var. syzygios Privot, Ann. Sci. Nat., Sér. Bot., 15, 1935,
134; Murray, in Manual, 5th ed., 1939,
283.) From Latin, yoked.

Differs from Veillonelle gazogens only by its ability to grow under an atmopheric pressure of 4 cm mercury, with the formation of H<sub>2</sub>S in small amounts by some strains, and the production of nitrites from nitrates.

Source: Found by Herzberg in 30 per cent of normal mouths and in 100 per cent of saliva from scarlet fever patients.

#### FAMILY VII. LACTOBACTERIACEAE ORLA-JENSEN.

(Orla-Jensen, Jour. Bact, 8, 1921, 271; Streptobacteriaceae Bergey, Breed and Murray, Preprint, Manual, 5th ed., 1938, 71)

Long or short rods, or coeci which divide like rods in one plane only, producing chains, but never tetrads or packets. Non-mottle except for certain cultures of streptococci. Gram-positive Pigment production is rare; a few species form a yellow, orange, red or rusty brown pigment. Surface growth on all media is poor or absent. Some species are strictly anacrobic. Carbohydrates are essential for good development; they are fermented to hetic acid, sometimes with volatile acids, alcohol and CO<sub>2</sub> as by-products (except for the non-fermenting Diplococcus magnus). Gelatin is very rarely liquefied. Nitrate is not reduced to nitrite. Found regularly in the mouth and intestinal tract of man and other animals, dairy products, fermenting vegetable juices. A few are highly pathogene.

#### Key to the tribes of family Lactobacteriaceae.

- I. Cocci occurring singly, in pairs and in chains
- Tribe I. Streptococceae, p 303.
- Rods occurring singly, in pairs and in chains Individual cells may be very long or even filamentous.

Tribe II Lactobacilleac, p. 349

## TRIBE I STREPTOCOCCEAE TREVISAN.

(I generi e le specie delle Batteriacee, 1889, 29 )

Cells spherical or clongate, dividing in one plane only, usually occurring in pairs or chains. A few species are stret ancerobes, none grow abundantly on solid media. Carbohydrates and polyalochols are changed either by homofermentation to lactic acid or by heterofermentation to lactic and acetic acids, alcohol and carbon diovide. Some pathogenic species grow poorly without blood serim or other carbohment fluids. Catalias necestive

## Ken to the genera of tribe Streptococceae.

- Parasites, growing poorly on artificial media. Cells usually in pairs, often elongated. Anaerobic species rarely in tetrads or small clumps. Genus I. Dielococcus, p. 305.
- II. Parasites and suprophytes Normally forming short or long claims Perment glucose to lactic and with practically no other aculs or CO. Genus II Steptococcus, p. 312
- III. Saprophytes Form chains of corer to short rods in plant juices and milk. Perment glucose with the production of CO<sub>L</sub> lactic acid, acetic acid and ethyl alcohol. Mannitol is formed from fructose.

Genus III. Leuconostoc, p 316.

# Genus 1. Diplococcus ll'eichselhaum

(Weichselbrum, Wiener med Jahrb , 82, 1831, 483, Hydlococcus Schroeter, in Cohn, Kryptogamen Flora v Schlesien, 1885, 152, Pseudohplococcus Bonome, Cent. f. Bakt.,

<sup>\*</sup> Revised by Prof. E. G. D. Murrey, McGill University, Montreal, Canada, September, 1938; unacrobic section adapted from papers by Dr. A. H. Prévot, Institut Pasteur, Paris, Trace, 1938, further revision by Lt. Col. Piliott S. Robinson, M.C., Washington, D. C., January, 1944

2, 1888, 321; ? Pneumococcus Schmidlechner, Ztschr. f. Geburtshilfe u. Gynākol., 56. 1905, 201; not Pneumococcus Arloing, Compt. rend. Acad. Sci., Paris, 109, 1889, 430; Mogallia Enderlein, Sitzb. Gesell. Naturf. Freunde, Berlin, 1917, 309.) From Greek diploos, double; lokkos, a grain or berry; M. L., a sphere.

Cells usually in pairs, sometimes in chains or more rarely in tetrads or small clumps Young cells Gram-positive. Parasites sometimes growing poorly or not at all on artificial media. Fermentative powers usually high, most strains forming acid from glucose, lactose, sucrose and inulin. The aerobic species are bile soluble while the

anaerobic species are not bile soluble.

The relationships of the strictly anaerobic diplococci placed in this genus by Prévot (Ann. Sci. Nnt., Ser. Bot , 15, 1933, 140) to pneumococci are not yet entirely clear. The anacrobic species are included here in the hope that this arrangement will stimulate research

The type species is Diplococcus pneumoniae Weichselbaum.

Key to the species of genus Diplococcus.

Acrobic, facultative. Bile soluble.

1. Diplococcus pneumoniae.

II Strictly anaerobic. Not bile soluble. A Greater than 1 micron in diameter.

1 Carbohydrates not attacked.

2. Diplococcus magnus.

B. Not greater than 1 mieron in diameter.

1. Acid from glucose and lactose. a. Capsulated. Pathogenie.

3. Diplococcus paleopneumoniae. as. Not capsulated. Non-pathogenic.

4. Diplococcus plagarum-belli.

2. Acid from glucose, not from lactose.

a Grows on ordinary culture media. Non-pathogenic. 5. Diplococcus constellatus.

aa. No growth on ordinary culture media. Pathogenic,

6. Diplococcus morbillorum.

1. Diplococcus pneumoniae Weichselbaum. (Microbe septicémique du salive, Pasteur, Chamberland and Roux, Compt. rend. Acad. Sci , Paris, 92, 1881, 159; Micrococcus of rabbit septicemia, Sternberg, National Board of Health Bull., Washington, 2, 1881, 781; Coccus laneéolé, Talamon, Communication à la Société anatom de Paris, 68, 1883, 475; Micrococcus pyonenes tenuis Rosenbach, Mikroorganismen bei den Wundinfektionskrankheiten des Menschen, 1834, 30 (see Neumann, Cent. f. Bakt., 7, 1890, 177); Micrococcus pasteuri Sternberg, Trans. Pathol. Soc. of Philadelphia, 12, 1885, 162 (not Micrococcus pasteuri Trevisan, I generi e le specie delle Batteriacee, 1889, 34); Weichselbaum, Wiener med. Jabrb., 82, 1886, 485; Pneumoniemikrococcus or Pneumococcus, Frankel, Ztschr. f. klin. Medizin, 10, 1886, 402; Bacillus septicus sputigenus Flugge, Die Mikroorganismen, 2 Auf, 1886, 262; Bacillus salivarius seplicus Bionds, Ztschr. f. Hyg , 2, 1887, 195; Diplococcus lanceolatus sive capsulatus Fol and Bordoni-Uffreduzzi, Archivio per le Sci Med., 11, 1887, 387; Streptococcus lanceolatus pasteuri Gamaleia, Ann. Inst. Past., 2, 1888, 442; Streptococcus lanctolatus Gamaleia, ibid., 443; Klebsielle salivaris Trevisan, I generi e le specie

delle Batteriacee, 1889, 26; Micrococcus rosenbachii Trevisan, ibid., 33: Micrococcus puogenes-tenuis De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1031; Micrococcus pneumoniae crouposae Sternberg, Cent. f Bakt , 12, 1892, 53; Diplococcus lanceolatus capsulatus Kruse and Pansini, Ztschr. f Hyg. 11, 1802, 335; Diplococcus lanceolatus incorrectly ascribed to Frankel by Binaghi, Cent. f. Bakt , I Abt , 22, 1837, 278; Micrococcus tenuis Migula, Syst d Bakt., 2, 1900, 193; Bacterium pneumontae Migula, ibid., 317, Bactersum salitarium Migula, abid . 379; Streptococcus pneumoniae Chester. Determ. Bact., 1901, 63; Micrococcus lanceolatus Longcope, Jour Med Res. 7 (N.S. 2), 1902, 220; Pneumococcus lanceolatus Schmidlechner, Ztsehr f Geburtshilfe u. Gynäkologie, 56, 1905, 201; Pneumococcus pneumoniae Fried, Jour. Exp Med , 57, 1933, 111 ) From Greek pneumonia, inflammation of the lungs

Monas pulmonale Klebs (Arch f exper. Path. u. Pharmakol, 4, 1875, 472) is inadequately described by Klebs and ought not to be regarded as identical with Weichselbaum's organism.

Common name: Pneumococcus

The organisms occur as oval or apherical forms typically in pairs, occasionally singly or in short chains, 05 to 125 microns. The distal ends of each pair of organisms tend to be pointed or lancet-shaped. Encapsulated. Non-motile Young cells, Gram-positive.

Gelatin stab: Filiform or beaded growth. No liquefaction.

Infusion agar colonies: Small, transparent, grayish, with entire margin. Elevation bigh convex, glistening, mucold to watery.

On blood agar, the colonies are elevated at the center with concentric elevations and depressions. Hemolysis usually slight but often marked in ancerobic culture; methemaglobin formation with green zone around colony

Beef heart infusion broth Uniform turbidity with variable amount of sediment.

Addition of glucose, scrum, whole blood or ascitic fluid enhances growth.

Meat extract media: Crowth irregular, usually poor if any.

Inulin serum water Henelly said with

Inulin serum water. Usually acid with congulation

Litmus milk: Usually acid with congulation.

Potato · No growth.

Whole bile or 10 per cent solutions of sodium taurocoloate or sodium glyco-cholate added to actively growing broth cultures will dissolve the organisms. It is customary to use from 0.1 to 0.5 ml of bule for each 0.5 ml of culture

Aerobic, facultative.

Optimum temperature 37°C. Usually no growth at 18° to 22°C

no growth at 18° to 22°C
Optimum initial pll 7 8
Source Sputum, blood and evudates in

pneumona; cerebrospinal fluid in meningitis; mastoidilis; otitis media, porttonitis, empyema; pericarditis, endocarditis, arthritis, saliva and secretions of respiratory tract in normal persons. Commonest cause of lobar pneumonia.

Habitat. The respiratory tract of man and animals.

At present, thirty-one types of Diplococcus pneumoniae are recognized on the basis of serological reactions, chiefly the Neufeld "Quellung" phenomenon as induced by type-specific immune rabbit scrums. Following the description of Pneumococcus I by Neufeld and Händel (Arb. a. d k Gesundheitsamte, 34, 1910, 293), Dochez and Gillespie (Jour Amer Med. Assoc , 61, 1913, 727) divided the species into Types 1, 2, 3 and a heterogenous group 4; Cooper, Edwards and Rosenstein (Jour. Exp. Med , 49, 1929, 461) separated Types 4 to 13 Irom the atrains previously designated as group 4, and later Cooper, Rosenstein, Walter and Peizer (Jour. Evp. Mcd., 55, 1932, 531)

continued the classification to Type 32. Due to marked cross-reactions, it was subsequently decided that Type 6 was identical with Type 26, and that Types 15 and 30 were identical. This resulted in the deletion of the Cooper Types 26 and 30, thus leaving thirty of the original thirty-two types. Type 33 (Wilder) has been described by Walter, Blount, Beattie and Cotler (Jour. Inf. Dis., 66, 1940, 181) as a distinct type; sufficient recognition has been accorded to justify the acceptance of this type, thereby making a total of thirty-one types of the species. In a still more recent publication, Walter, Gucvin, Beattie, Cotler and Bucca (Jour. Immunol., 41, 1941, 279) recommend the addition of nine new types and eight subtypes. These, together with now strains reported by Kauffmann, March and Schmith (Jour. Immunol.. 39, 1040, 397), if eventually recognized, would make a total of fifty-five types. Eddy still more recently, taking into account all known types, raises the number of recognized types to seventy five (U. S. Public Health Repts., 59, 1944. 449-468).

NOTE 1. Streptococcus mucosus Howard and Perkins (Howard and Perkins, Jour. Med. Res., 6 (N.S 1), 1901, 174; Diplococcus capsulatus incorrectly attributed to Frankel by Binaghi, Cent f. Bakt , I Abt., 22, 1897, 273; Streptococcus mucosus Schottmuller, Munch. med. Wehnsehr., 50, 1903, 909, Streptococcus lanceolatus var. mucosus Park and Williams. Diplococcus lanceolatus var. mucosus Park and Williams, Diplococcus mucosus Park and Williams, Pneumococcus mucosus Park and Williams, Jour. Exp Med , 7, 1905, 411; Streptococcus mucosus capsulatus Buerger. Cent. f. Bakt , I Abt , 41, 1906, 314 ) This organism is no longer recognized as a separate species Dochez and Gillespie (Jour. Amer. Med Assoc , 61, 1913, 727),

Wirth (Cent f. Bakt., I Abt , Orig , 103, 1928, 40) and others have established the identity of strains of this group as Diplococcus pneumoniae, Type 3.

Bucrger (Cent. f. Bakt., I Abt., Orig, 41, 1906, 314) lists the following capsulated closely related streptococci: Streptococcus involutus Kurth, Arb. a. d. l. Gesundheitsamte, 8, 1893, 449 (Diplococcus involutus Winslow and Winslow, The Systematic Relationships of the Coccaceae, New York, 1908, 131); Streptococcus aggregatus Scitz, Cent. f. Bakt., I Abt., 20, 1896, 854; Streptococcus capsulatus Binaghi, Cent. f. Bakt., I Abt, 22. 1897. 273: Streptocoque auréole, Le Roy des Barres and Weinberg, Arch de Méd. expér. ct d'anat, patbol., 2, 1899, 399; Leucanostoc hominis Hlava, Cent. I Bakt., I Abt., Orig., \$2, 1902, 263

Note 2. Pneumococci, regardless of scrological type, manifest three chief culturo phases (or stages): Mucoid, Smooth, and Rough. The Mucoid (M) form corresponds to that previously designated as Smooth (S) and represents the typical phase of the species; Smooth (S) supercedes the earlier term Rough (R); and the present Rough (R) form is a relatively nowly-described variant. The most frequently observed dissociative trend is M → S → R. Serological types are recognizable only in the Muroid form due to the presence of type-specific polysaccharides in the capsular material, both Smooth and Rough forms are devoid of capsular material, but possess species specific antigens common to all members of the species. Smooth and Rough forms are non-pathogenic, possess distinctive growth characteristics, and require special technie for accurate observations The cultural characteristics given are those of the mucoid and smooth phases only, e. g , see growth in broth.

\*† Diplococcus magnus Prévot. (Diplococcus magnus anaerobius Tissier and

Anaerobie section reviewed by Dr. Ivan G. Hall, New York, N. Y.

<sup>†</sup> These anacrobic diplococci and streptococci, many of which are putrefactive

Martelly, Ann. Inst. Past., 16, 1902, 885; Prévot, Ann. Sci. Nat., Sér. Bot, 15, 1933, 140.) From Latin magnus, large.

Large spheres: 1.5 to 18 microns, usually in pairs, sometimes occurring singly, in small clumps or very short chains. Gram-positive.

Gelatin Growth slow, scanty. No liquefaction.

Deep agar colonies: After 24 hours at 37°C, lenticular, whitish, granular, margin finely cut. No gas produced.

Broth: Turbid, clearing in 4 or 5 days resulting in a viscous mass similar to the zoogloca which Clostridium bifermentans forms.

Peptone water. Slight turbidity Indolo not formed.

Milk: Unchanged.

Fibrin not digested.

Sterilized urino. Turbid in 3 to 4 days The urea is attacked forming (NII<sub>1</sub>)<sub>2</sub>CO<sub>2</sub>.

The urea is attached forming (NII<sub>2</sub>)<sub>2</sub>CO<sub>3</sub>.

Proteoses: Digested and disintegrated forming (NII<sub>4</sub>)<sub>2</sub>CO<sub>2</sub> with the liberation of NII<sub>4</sub>.

Carbohydrates not attacked

Optimum pH 7.0 Lamits of pH 55 to 85.

Temperature relations Optimum 37°C Grous from 18° to 37°C. Killed in five minutes on boiling or in half an hour at 60°C.

Non-pathogenic

Strict anaerobe

Distinctive characters: Large size, very marked alkalinizing power

Source Isolated by Tissier and Martelly (loc. cit) from putrelying butcher's ment Isolated by Prévot (loc. cit.) from a case of acute appendicitis. Habitat: Human digestive tract. Very common on butcher's meat in the process of putrefaction Probably occurs in household dust.

3. Diplococcus paleopneumoniae Prévot. (An anaerobic pseudopneumococcus, Rist, Thèse de Paris, 1898, Der Fränkelsche Diplococcus, Bolognesi, Cent f. Bakt., I Abt., Orig., 43, 1907, 113; Prévot, Ann. Sci. Nat., Scr. Bot., 15, 1933, 143) From Greek paleus, old and pneumonia, inflammation of the lungs.

Spheres About 07 to 10 micron, occurring in pairs, rarely occurring singly or in very short chains. Capsulated.

Gram positive

Gelatin: No liquefaction

Deep agar colonies; Probably len-

Agar slant colonies: Round, raised, transparent, dew-drop.

Broth Opalescent turbidity which settles as a rather abundant, powdery, flocculent precipitate No gas produced. Glucoso or lactose broth. Rapid,

abundant growth.

Peptone water (2 per cent): Very slow development After 4 or 5 days at 37°C

growth very poor Milk, Good growth. Partial congu-

lation

Blood agar. Very rapid, abundant growth.

Acid from glucose and lactose.

Temperature relations Optimum 37°C. No growth at 20°C nor at 42°C. Killed at 55°C.

Pathogenic Strict anaerobe.

Distinctivo characters. Resembles

and gess-forming, seem to us so different from the lettmentative microverophilic disconseri, streptococci, teuconostace and lactobarillt that we believe they should be placed in genera and in a lamily separate from Lactobacteraccae. Prévot in a discussion (Ann. Inst. Past., 67, 1911, 57) that has just reveled us (Oct., 1915) recognizes this difference in physiology. He would solve the difficulty by returning the fermentative diphococci and streptococci to the family Corroccae because of resemblances in morphology which do not seem to us to be lundamental—The chitors.

Diplococcus pneumoniae but is a strict anaerobe; highly pathogenic.

Source: Isolated by Rist (loc. cit.) from an osseous abscess; by Bolognesi (loc. cit.) from lesions of pleuropneumonia.

Habitat: Buccal-pharyngeal cavity of man and rodents.

 Diplococcus plagarum-belli Prévot. (Diplococcus from septie wounds, Adamson, Jour. Path. and Bact., 22, 1919, 393; Prévot, Ann. Sci. Nat., Sér. Bot., 15, 1933, 157.)
 From Latin plaga, wound; bellum, war.

Spheres 0.6 to 1.0 micron, occurring in pairs of unequal size or in short chains. Gmm-positive.

Gelatin: No liquefaction.

Deep agar colonies: Appear after 24 to 48 bours, gradually increasing in size to 2 mm in diameter; lenticular, regular, almost transparent. Gas not produced, even in glucose agar.

Broth: Growth precipitates in 5 or 6

days No gas produced.

Indole not formed.

Milk: Strongly acidified and coagulated in 2 to 3 days.

Serum not digested.

Acid but not gas from glucose, maltose, lactose and sucrose. No acid from mannitol

Temperature relations. Optimum 37°C. Not always killed in half an hour at 80°C.

Non-pathogenic.

Strict angerobe

Source: Sixteen strains isolated from fifty-one cases of septic war wounds.

Habitat · Common in septic wounds.

 Diplococcus constellatus Prévot-(Compt. rend. Soc. Biol. Paris, 91, 1924, 426.) From Latin constellatus, studded with stars.

Description in part from Prévot, Ann Sci. Nat., Sér. Bot., 15, 1933, 158.

Spheres: 0 5 to 0.6 micron, occurring in pairs and tetrads, rarely in very short chains, never in clusters. Grampositive.

Gelatin: Good growth, No lique-

Deep agar colonics: At first very small, lenticular, biconvex, thick, opaque, yellowish, 0.5 to 1.5 mm in diameter. Each colony surrounded by many small satellite colonies visible microscopically

Broth: Growth slow, poor. After 48 hours a slight homogenous turbidity which quickly clears, leaving a slight powdery sediment. Neither gas nor odor produced.

Glucose broth: Growth rapid, abundant.

Proteins not attacked.

Blood broth: Good growth. No hemolysis.

Milk: Poor growth. No change.

Peptone water: Good growth. Not acidified. Indole not formed.

Neutrol red broth unchanged.

Acid but not gas from glucose, arabinose. Slightly acid from glycerol. No acid from lactose, inulin, maanitol or dulcitol.

Optimum pH 6 0 to 8 0.

Optimum temperature 37°G. Feeble growth at 22°C. Not thermo-resistant

Strict anserobe.

Distinctive character: The microscopic appearance of agar colonies each of which is surrounded by a constellation of satellites.

Source: Isolated from a case of chronic, eryptic tonsillitis. Later isolated from pus in acute appendicitis

Habitat: Digestive tract, especially the lymphoid tissues, as tonsils and appendix.

6. Diplococcus morbillorum Prévol. (Diplococci from cases of measler, Tunnicliff, Jour. Amer. Med. Assoc., 63, 1917, 1029; Diplococcus rubolar Tunnicliff, Jour. Int. Dis., 52, 1933, 39; Prévol. Ann. Sci. Nat., Sér. Bot., 15, 1933, 1818 orignal name withdrawn by Tunnicliff, Jour. Inf Dis., 58, 1936, 1.) From Latin morbus, disease; M. L. morbilli, measles

Spheres 06 to 08 micron, occurring in short chains, rarely in small masses Gram-positive.

This organism does not develop on ordinary culture media. The addition of fresh scrum or ascitic fluid is necessary

Gelatin: No liquefaction.

Serum agar colonies: Very small, punctiform, appearing after 5 to 22 days No gas produced.

Glucose agar containing ascitte fluid and blood; Colonies are slightly larger and appear more rapidly, greenish.

Blood agar colonies: Surrounded by a greenish halo. May be large and mosst. Gas not produced

Broth: Very poor growth.

Hemolysed blood broth: Growth flocculent, leaving the liquid clear. Milk: Unchanged by most strains. Acidified and congulated by four strains. Indole not formed

Bile: Not soluble in bile.

Acid from glucose, sucrose and maltose.

Temperature relations: Optimum 37°C. Killed in 45 minutes at 57°C. Withstands -2°C for two weeks.

Strict anaerobe. Most strains become microaerophilic with transfers.

Distinctive characters. Greenish colonics on blood media; poor growth on ordinary media.

Source: Isolated from the throat and blood in measles.

Habitat. Nose, throat, eyes, ears, mucous secretions and blood from cases of measles

#### Genus II. Streptococcus Rosenbach.\*

(Rosenbaeli, Mikroorganismen bei Wundinfektionskrankheiten des Menschen, 1881, 22; Arthrostreptolakkus Hueppe, Wiesbaden, 1886, 141; Sphacrooccus Marpman, Erghanungsheite z. Cent. f. allg. Gesundheitspfleeg. 2, 1889, 121; Pernontiala, Bobeiia, Schuetzia Trevisan, I generi e le specie delle Batteriacee, 1889, 29; Lactocaccus Beijorinek, Arch. nečrl. d. sci. evaetes, 8čr. 2, 7, 1901, 213; Hypnocaccus Bettencourt et al., Cent. f. Bakt., I Abt., Orig., 55; 1901, 55; Myrococcus Gonnermann, Dester. u Ungar. Ztsehr. f. Zuckerind. u. Landwirtseh., 36, 1907, 883; not Myzacoccus Tharter, Bot. Gaz., 17, 1802, 404; McLococcus Amiradzibi, Med. Zurn., 4, 1907, 309; Diplostreptococcus v. Lingelsheim, in Kolle and Wassermann, Handb. d. path. Mikroorg, 2 Aufl., 4, 1912, 494; ? Brachybacterium Troili-Petersson, Cent. f. Bakt., II Aht., 11, 1903, 138; Pscudostreptus Enderlein, Sitzb. Gesell. Naturf. Freunde, Berlin, 1917, 309, Planostreptococcus Meyer, Die Zelle der Bakterien, Jena, 1912, 4; Stretus Enderlein, Sitzber. Gesell. Naturf. Freunde, Berlin, 1930, 101; Peptostreptocaccus Kluyver and Van Niel, Cent. f. Bakt., II Aht., 94, 1936, 391.) From Greek streptus, flexible or pliant; Greek kalkos, a grain or berry; M. L., a snhere.

Cells spherical or ovoid, rarely elongated into rods, occurring in pairs, or short or long chains, never in packets or zooglocal masses. Capsules are not regularly formed, but become conspicuous with some species under certain conditions. Gram-positive, some species decolorizing readily. A few cultures produce a rusty red growth in deep agar stab, or a yellow or orange pigment in starch broth. Growth on artificial media is slight. Agar colonies are small. Surface colonies are translucent. Colonies may be effuse, convex or mucoid. Some species are aided by the addition of native proteins Mostly facultative anacrobes, with little surface growth in stab cultures. A few are strict anaerobes. Some of the latter attack proteins with production of gas and foul odors. Carbohydrate fermentation by all others is homofermentative, with dextrorotatory lacticacidas the dominant product, while volatile acids, other volatile products and CO2 are either absent or produced in very small amounts. Inulin is rarely attacked. Nitrate is not reduced to nitrite. Not soluble in bile. Common wherever organic matter containing sugars is accumulated. Regularly in the mouth and intestino of man and other animals, dairy products, fermenting plant juices. Some species are highly pathogenic

The type species is Streptococcus pyogenes Rosenbach.

Note: The classification of streptococci is beset with many difficulties and it seems advisable for the present to accept only such described species about which there is reasonable agreement. With present knowledge, many species which have been separated can justifiably be considered as identical with older species and have been treated as such here. The descriptions of certain other species and mane with no present significance. It is admitted there are grounds for belief that more than one species may be included in certain of the species described here, but the onus of proof lies with the investigators interested in them. It is hoped that the simplification introduced will prove useful as a starting point for the more exact differentiation and description of the species of Streptacoccus. The general arrangement used is in

<sup>\*</sup> Revised by Prof E G D Murray, McGill University, Montreal, Canada, in conaultation with Prof G J Hucker, New York State Experiment Station, Geneva, New York and Prof. J. M. Sherman, Cornell University, Ithaca, New York, June, 1938; further revision by Prof. J M Sherman, February, 1944.

harmony with the suggestions made by Hucker (Proc. 2nd Internat, Cong. for Microbiology, London, 1936, 127) and Sherman (Bacl. Reviews, 1, 1937, 3).

Secological reactions are included as fir as possible in the descriptions but the true significance of these methods is not known and on that account they are not stressed in the primary classification.

Throughout the history of this genus motile streptococci have been reported occasionally (e.g., Streptococcus herbarum Schieblich, Cent. f. Bakt., I Abt., Orig., 124. 1932, 269; Koblinuller, Cent f Bakt . 1 Mbt , Ong , 155, 1931, 310, Stölling, Uter die Streptokokken des normal reifenden Tilsiter Kases Inaug Dies , Kiel, 1935, 51; Pownall, Brit. Jour Lyn Path , 46, 1935, 155) but it is not known whether these constitute definite species or whether (Levenson, Ann Inst Past , 60, 1938, 99) motile individuals occasionally appear in ordinarily non-motile species.

The anacrobic strentococci have not been sufficiently studied to be sure whether they should be included in the genus Streptococcus or given separate generic rank. Their metabolic processes seem reason for the latter view. The descriptions given are taken from Privat (Ann. Ser. Nat., Ser. Bot., 15, 1933, 23).

The material is arranged accordingly in three categories: A key and complete descriptions have been prepared for clearly defined species, species of uncertain taxonomic relationships have been placed in Appendix I with their necessarily incomplete descriptions, while even less valid and undentifiable species are merely listed in Appendix 11.

## Key to the species of genus Streptococcus.

I. Pacultative anaembic species

A. Progenic group Na growth at 10°C No growth at 45° C Cicnerally beta hemolytic. Generally do not cardle himas culk and reduce hismus slowly if at all. Mennitol and glycerol generally not fermented Not tolerant of 01 per cent methylere blue, 65 per cent NaCl and nil

9.6 Produce aminents from peptone 1. Solum hippurate not hydrolyzed

a. Lactore fermented

le Sorlated not fermented but trefulore fermented. Lancefield Group 1.

1. Street concus paraents ble Sorbitol fermented and trebalise not fermented. Janefell Group C

2. Street warne a war femicus

as Lactore may or may not be ferriented. Lacre Sel 1 Group C. h Trelation put fermented

3 Strept meent ernt. life Tret show fermented

4. Streptwiczna egnynmilie

2 Sat malignesse ladedared. Jamesell Group B & Arrest a cost against as

B Virifargeren Augusthat 19'C Growthat 65'C few exercises in Sugar a special Bet of to antiseen taghinian the state as Igiacon I generalia in I formented, a arrel 2 early . Not a lease of Of the early satisfied Har, # Sque earl Not 7 or 111 96 Min help hemolytic (though they may be under anaerobic conditions) but show varying degrees of greening of blood. Do not produce ammonia from peptone (few exceptions in Streptococcus milis).

Lactose is fermented.

- a. Do not grow at 50°C. Greening or indifferent in blood agar. Raffinose, inulin, salicin and devtrin generally fermented. Esculin generally attacked. Growth with 2 per cent NaCl.
  - b. Do not survive 60°C for 30 minutes. Starch not hydrolyzed. Not tolerant of bile.
    - Mucoid colonies produced on sucrose and raffinose media
       Streptococcus salivarius.
    - cc. Colonies not mucoid on sucrose or raffinose media. Inulia not fermented.

7. Streptococcus milis.

bb. Survives 60°C for 30 minutes. Starch is hydrolyzed except by variety inufineceus. Tolerant of bile.

8. Streptocorcus boris (and varieties).

- aa. Grows at 50°C. No action on blood. Esculin not attacked. Raffinose, inulin, salicin and dextrin not fermented. No growth in 2 per cent NaCl.
  - 0. Streptococcus thermophilus
- 2. Lactose not fermented. Tolerant of bile.
- C. Locite group Growth at 10°C. No growth at 45°C. Reduce litmus prior to curdling of litmus milk. Sorbitol and glycerol not fermented. Not
  - beta hemolytic. Tolerate 0.1 per cent methylene blue, but do not tolerate 6.5 per cent NaCl or pll 0.6.

    1. Maltose and deatrin fermented. Ammonia produced from peptone

Growth at 40°C Group N of Shattock and Mattick.
11. Streptococcus lactis.

2 Maltose and usually dextrin not fermented. Ammonia not produced from peptone No growth at 40°C.

12. Streplococcus cremoris.

D. Enterococcus group. Growth at 10°C. Growth at 45°C. Usually reduce litmus prior to curdling litmus milk. Sorbitol, glycerol and manufel generally fermented. May or may not be beta hemolytic. Tolerate 0.1 per cent methylene blue, 6.5 per cent NaCl and pH 9.5. Ammonia produced from pentone. Lancefield Group D.

1. Not beta hemolytic.

- a. Gelatin not liquefied.
- 13. Streptococcus facculis.
- 14. Streptococcus liquefaciens.
- Beta hemolytie.
  - a Mannitol and sorbitol fermented.
    - 15. Streptococcus zymogenes.
  - aa Mannitol and sorbitol not fermented.

    16. Streptococcus durans.
- II. Anaerobie species.
  - A. Strict angerobes.
    - 1. Gas and fetid odor produced.
      - a. No general turbidity in broth.

## FAMILY LACTORACTECISCS

b. Acid from maltose.

bb. No acid from maltose.

18. Streptococcus Je

aa. Turbidity in broth.

b No gas in Veillon's semisolid

bb blumlant gra in semisolid ag:

2. No gas and we fettel odor produced
a. Milk not consulated

21, Streptococe

aa. Milk congulated
b Viscous sediment in broth

with age 22. Streptococc.

bb. No verous sediment in brott blacken with age.

23. Streptocor. .

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B Microaerophilic

1. Strictly anacrobic on isolation, later m

1. Streptococcus pyogenes ito-enimch (Fehlelsen, Ueber Erysspel, Dent Zeit. f. Chir., 16, 1882, 301, Erysspelkokken, Febleisen, Die Actiologie des L'rympels, Berlin, 1883; Rosenbach, Mil roorganismen bei Wundinsektionskrankheiten des Menschens, 1881, 22, Streptneoceus erysipelatos (sie) Rosenbach, ibid , 22; Micrococcus erysipelatis Zopf, Die Spaltpilize, 2 Aufl., 1881, 86, Streptococcus erysipelatis Zopf, Die Spatipilze, 3 Aufl., 1885, 51; Streptococcus erysipelatosus Klebs, Die Allg Path , Jena, 1887, 318; Micrococcus scarlatinae and Streptococcus scarlatinge Klein, Report of the Medical Officer of the Local Government Board for 1885-1886, No 8, 1887, 85, Streptococcus conglomeratus Kurth, Arb. d. k. Gesundheitsamte, 7, 1891, 389; Streptococcus longus von Laugelsheim, Zischr. f. Hyg., 10, 1831, 331 and 12, 1831, 308; Streptococcus puerperalis Arloing, Septietmie puerperale, Paris, 1832 (Jordan, Brit Med Jour, 1912, 1); Staphylococcus erysipelatos Hesse, Ztschr. f. Hyg., \$4, 1900, 317; Streptococcus longus pathogenes and erystpelatos Schottmüller, Münch, med. Wehnschr., 50, 1903, 909; - 1. Streptococcus longus herselyticus Sachs, Ztechr. f. Hyg., 63, 1909, 466; Streptococcus

l'arış, longier, imitron Abt., G the long hemoty ' to the Orig., / ' axis of the demico. 111, bacillary 58, 191 10 Dates, short מסמומוסם בתוניהם י 375: 2 hemol C'mentes often tentral mouse and (N.5 tiram positive. genes t th uncertain. No rend

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Cons-

'rim'ry acrobic culmally fail; growth is 'transparent colonies. 't than, grayish white or 'abundant in the confronth is increased 'orse protein.

Buct, 52, 1936, 511).
No change. Not curdled

can No change. Not curdled

Greduced.

-tucose, maltose, sucrose

acid from ambinose, lac-

colonies to remain discrete. Growth increased by addition of blood or native proteins. Pairs or short chains in surface growth and longer chains in condensation fluid of slants.

Broth: Floculent sediment of tangled, chains, supernatant broth often clear except in very young cultures. No pellicle.

Potato: Very slight or no visible growth.

Litmus milk. Acid, seldom curdled, and litmus reduced slowly or not at all. Acid from glucose, maltose, lactose, sucrose, salicin and trobalose. No acid

from inulin, raffinose, arabinose, glycerol, mannitol, sorbitol or dulcitol. No hydrolysis of sodium bippurate.

starch or esculin.

Ammonia is produced from pentone.

Temperature relations: Optimum temperature around 37°C. No growth at 10°C or 45°C. Does not survive 60°C for 30 minutes.

Chemical tolerance. Tolerates 2 per cent NaCl but not 4 per cent and 6 5 per cent Final pH in gluces broth 48 to 6.0; no growth at pH 9.6. Methylene blue 0.01 per cent and 0.1 per cent not tolerated and not reduced Inbibited by bile but not soluble.

Action on blood: Superficial and deep colonies cause bemolvsis in blood agar. usually with a wide zone surrounding the colony, which may have a well-defined margin circumscribed by a zone of concentrated bemoglobin: the margin of the zone is ill-defined with some strains. Conditions defined by Brown (Rockefeller Inst Med. Res, Monograph 9, 1919, 14) known as beta hemolysis. Soluble antigenic hemolysin of more than one kind produced in fluid cultures; influenced by constitution of medium and presence of serum; one is oxygen-sensitive and another is oxygen-stable. Special precautions necessary for its demonstration (F. Smith, Jour. Bact. \$4, 1937, 585, 603),

Toxin: An erythrogenic toxin is pro-

duced; commonly associated with scarlet fever. Relatively thermostable.

Fibrinolysin: Dissolves human fibrin but not fibrin of rabbit or ox blood. Markedly thermostable

Serology: Constitutes Group A of Lancefield (C substance; polysacharide) (Jour. Exp. Med., 67, 1933, 571). Types within the species are distinguishable (M substance; protein); 23 identified by Griffith (Jour. Hyg., 54, 1934, 542). Antigen common to the group (P substance; nucleo-protein) also present in other Gram-positive cocci.

Facultative anaerobe. Occasionally in primary culture from lesions, pus, etc. grows only in anaerobic culture.

Source: Human mouth, throat and respiratory tract; inflammatory exudates, blood stream and lesions in human disease of very varied character. Occasionally in milk and udder of cows. Dust in sick rooms, hospital wards and other contaminated sites.

Habitat: In human infections of many varied types. Occasionally in udder infections of cattle and perhaps other animal sources

2. Streptococcus zooepidemicus Frost and Engelbrecht. (Animal progenes Type A of Edwards, Jour. Batt., \$7, 1934, 527; Frost and Engelbrecht, A Revision of the Genus Streptococcus, privately published, 1936, 3 pp and The Streptococcis, 1940, 25; Streptococcus specenes animalis Seelemann, Deutsche tierarxt Wehnschr, \$0, 1942, 8 and 48) From M. L, derived to mean animal condemnates.

Morphology and general cultural characters resemble Streptococcus pyogenes. Mucoid colonies are common. Capsules are constantly demonstrable and prominent. Gram-positive

Gelatin stab: No liquefaction.

Litmus milk: May be curdled, hims not reduced or slowly after curdling.

Acid from glucose, lactosc and sorbitol. Acid may be produced from maltose, sucrose and salicin. No acid from arabinose, trehalose, raffinose, inulin, glycerol or mannitol.

Does not hydrolyze sodium hippurate, but starch and esculin may be split.

Ammonia is produced from pertone. Temperature relations: No growth at 10°C or at 45°C. Does not survive 60°C for 30 minutes.

Chemical tolerance Tolerates 2 per cent NaCl but not 4 per cent and 65 per cent. Final pH in glucose broth 45 to 52. No growth at pH 96. Methylene blue 0 01 per cent and 0 1 per cent

not tolerated and not reduced

Action on blood: Beta hemolysis Serology: Group C of Lancefield (loc. cit.). Cross precipitation with Streptococcus coui

Facultative anaerobe

Source: Blood stream, inflammatory exudates and lesions of diseased animals. Not known from man.

Habitat: Disease process of domestic and laboratory animals. (Horse: endometritis, foetus. Hog: septicemia. Cow: septicemia, metritis, foetus Fowle: slipped tendon Guinca pg lymphadenitis. Rabbit: septicemia. Fox: pneumons.)

3. Streptococcus equi Sand and Jensen (Bacıllus adenttis equi Baruchello, Soc Veter. de Venetie, Undine, 1836, Giornale di anatomia fisiologica et natologia degli animali domestici. Prsa. Sept. 1887, Sand and Jensen, Deuts, Ztschr f. Tiermed 15, 1888, 436, dated December 27, 1887, Vetermary Congress, Copenhagen, 1887; sometimes incorrectly credited to Schutz, Arch. f. wissens u. prakt Tierheilkunde, 14. 1888, 172; Streptococcus cappelletti Chester, Manual Determ Bact., 1901, 57; Streptococcus coryzae contagiosae equorum Schutz, in Eisenberg, Bakt. Diag., 3 Aufl., 1891, 270; Streptococcus schütz, Bongert, in Kolle and Wassermann, Handb. d path. Mikroorg., 2 Aufi , 6, 1913, 208.) From Latin equus, horse.

Possible synonyms: Streptococcus perstonitidis equi Hamburger, Cent f. Bakt., I Aht., 19, 1896, SS2 (Streptococcus perstonitidis Migula, Syst. d. Bakt., 2, 1900, 21), Streptococcus pyogenes equi Hutyro, in Lehmann and Neumann, Bakt Diag., 7 Aufl., 1927, 221.

None: Rivolta (Dei parassit vegetalicome introduzione allo studio delle malattie parassitarie e delle alterazione dell' alimento degli animali domestici. Turin, 1873, 161) described chains of cocci in adenuta scrophula equorum, morbus glandulosus.

Holth, reported by C. O. Jensen (Handb. d. Serumtherapie u. Serum diagnostik in d. Veterinar-med. (Klimmer-wolff-Esner), 2, 1011, 223), and Adsersen (Cent. f. Bakt. I Abt., Org., 76, 1015, 111) studied the fermentation reactions of Sand and Jensen's organism. Review of early ilterature given by Brocq-Rousscau, Forgeot and Urbain (Le etreplocoque gourmeux. Revue de Pathologic Comparée et d'Hygiene Générale, Paris, 1025)

Ovoid or spherical cells 0 6 to 1 micron in diameter, sometimes in pus the long axis of the cells are tinnsverse to the chain, and sometimes in the axis of the chain resembling streptobacilli; heallary forms are not rare; occur in pairs, short or long chains; very long chains common in broth cultures Capsulce often marked in blood of infected mouse and when grown in serum. Gram-positive.

Gelatin stab: Growth uncertain. No liquefaction.

Nutrent agar: Frimary seroble eultures from pus occasionally fail; growth is poor, small, convex, transparent colonies. Confluent growth is thin, grayish-white or yellowish and more abundant in the condensation water. Growth is increased particularly hyborse protein.

Broth: Poor growth even in infusion broth; growth increased by serum (Evans, Jour. Bact, 52, 1936, 541).

Litmus milk: No change. Not curdled and litmus not reduced.

Acid from glucose, maltose, sucrose and salicin. No acid from arabinose, lactose, trehalose, raffinose, inulin, glycerol, mannitol or sorbitol. No hydrolysis of sodium bippurate.

Temperature relations: Optimum temperature 37°C. Growth slow at 20°C. No growth at 10°C or 45°C. Does not survive 60°C for 30 minutes.

Chemical tolerance: Does not tolerate 65 per cent NaCl; final pH in glucose brotb 4.8 to 5.5. Methylene blue is not tolerated 0.01 per cent to 0.1 per cent. Inhibited by bile but not soluble.

Action on blood: On blood-agar, colonies are small and watery, dry out rapidly leaving flat glistening colony. Well-defined wide clear zone of hemolysis (beta hemolysis). Groath in serum broth gives a hemolysia netivo on horse corpuscles, less so on those of sheep and guinea pig.

Toxin: Subcutaneous injection eauses necrosis, other evidence of toxin production is defective.

Fibrinolysin · Usually does not lyse human fibrin; some strains reported to do so.

Serology. A member of Lancefield's Group C (Jour Exp. Med, 87, 1933, 571); cross precipitation with Species No. 22 (animal pyogenes) of Edwards (Jour. Bact, 27, 1934, 527). Cultures have been poor antigens for production of agglutinating serum and results have been unsatisfactory. Immunized rabbit serum may protect mice from infection, to which mice are very susceptible.

Pathogenicity high for white mice, low or no virulence for rabbits and guineanigs.

Facultative anacrobe; growth in primary culture often better in depth of medium.

Source. Pus from lesions and mucous membrane of upper respiratory tract of horses. Evidence of occurrence in man is unconvincing.

Habitat: Found only in strangles in horses.

4. Streptococcus equisimilis Frost and Engelbrecht. (Human C, Ogura, Jour. Jap Soc. Vct. Sci., 8, 1929, 174; Edwards, Jour. Bact , 23, 1932, 259; ibid , 25, 1933, 527; Sherman, Bact. Reviews, 1, 1937, 35; Frost and Engelbrecht, A Revision of the Genus Streptococcus, privately pub lished, 1936, 3 pp. and The Streptococci, 1940, 45.) From M. L., derived to mean similar to equi.

This species is ant to be confused with Streptococcus equi Sand and Janesen, but it is not as fastidious in its growthrequirements and shows greater toleranced methylene blue, lyses human fibris aid ferments glycerol and trehalose. It may or may not ferment lactose.

It is also apt to be confused with Strep tococcus pyogenes Rosenbach except for its greater tolerance of methylene blue, glycerol fermentation and especially Lancefield's serological grouping (Jour Exp. Med., 57, 1933, 371).

Spheres: Gram-positivs.

Gelatin: Not liquefied. .

Litmus milk: Acid, may be curdled, litmus not reduced before curdling.

Acid from glucose, maltose, sucrese, trehalose and glycerol; may or may not form acid from lactose and salicin. No acid from arabinose, raffinose, inulia, mannitol or sorbitol.

No hydrolysis of sodium hippurate bat may hydrolyze starch and esculin.

Ammonia is produced from peptone.

Temperature relations: No growth at
10°C and 45°C. Does not survive 60°C
for 30 minutes.

Chemical tolerance: Does not tolerate 65 per cent NaCl. Final pH in gluess hroft 54 to 4.6; no growth at pil 95. Methylene blue 0.1 per cent not tolerated, but Edwards (Kentucky Agr. Esp. Str. 1936, 1935; confirmed by Davis and Gurdar, Jour. Path. and Bact., 45, 1936, 197) finds resistance to 000025 molar methylene blue in infusion-castle digest broth. Rarely grows on 40 per cent bile-blood gazr.

Action on blood: Beta hemolysis. Fibrinolysin: Dissolves human fibria-Serology: Lancefield (loc. cit) Group C.

Facultative anaerobe.

Source: Human nose and throat, vaging and skin; erysipelas and puerperal fever. Uncommon in domestic animals and usually associated with other streptococci (Edwards, loc. cit).

Habitat: Human upper respiratory tract and vagina.

Streptococcus dysgalactiae Diernhofer (Milchw. Forsch., 15, 1932, 368), Group II Minett (Proc. 12th Internat. Vet. Cong.,

(Little, personal communication). Physiologically these organisms are like Human C types (Streptococcus equisimits Frost and Engelbrecht) except that they are not hemolytic.

5 Streptococcus agalactiae Lehmann and Neumann. (Streptococcus de la mammite, Nocard and Mollereau, Ann Inst. Past , 1, 1887, 100; Streptococcus nocard: Trevisan, I generi e le specie delle Batteriaces, 1889, 36 (this name rightly has priority and is valid but has remained unused and it would seem unwise to adopt it in place of a name familiar by usage), Streptococcus mastitis sporadicae Guille. heau and Streptococcus mastitis contagiosae Guillebeau, Landw. Jahrb. d. Schweiz, 4, 1832, 27; abst. in Gent f Bakt., 12, 1892, 101; Streplococcus agalactrae contagiosae Kitt, Bakterienkunde, Wien, 1833, 322; Lehmann and Neumann, Bakt. Diag , 1 Aufl., 2, 1896, 126; Streptococcus mastitidis Migula, Syst. d. Bakt., 2, 1900, 19.) From Greek, want of milk

According to Hucker and Harrison (N Y Agr. Exp. Sta. Tech. Bul 246, 1937, 9), Streptococcus agalactiae Lehmann and Neumann is identical with Group I of Minett, Stableforth and Edwards (Jour. Comp. Path and Ther. 48, 1933, 131) and Group A of Plastridge, Anderson, Brig-

N Y. Agr. Exp Sta. Tech. Bul. 232, 1935. Spherical or ovoid cells. 04 to 12 roicrons in diameter, occurring in chains of seldom less than four cells and frequently very long; the longer axis of the cells may be in the axis of the chain or may be transverse to it. Ghains may appear to be composed of paired cocci. Capsules(?) Gram-positive.

Gelatin stab: Gray, filiform growth No liquefaction

Nutr'ent agar. Small gray colonics.

Broth: Growth is variable in character; most frequently a sticky, flaky deposit which may adhere to the side of the tube but the supernatant fluid is clear; long chains are formed.

Starch broth, May produce yellow to orange sediment

Litmus milk: Acid followed by curdling. Litmus reduced subsequent to curdling and proceeds from the bottom upwards Little or no protectlysis.

Indole not formed

Acid from glucose, maltose, galactose, fructose, lactose, sucrose, mannose, dextrin and trehalose and at times from salicin. No acid from arabinose, raffir nose, inulin, vylose, mannitol, sorbitol or amygdalin. Slight amount of acid from glycerol.

Sodium hippurate is hydrolyzed. No hydrolysis of starch and esculin.

Nitrites not produced from nitrates.

Ammonia is produced from peptone. Temperature relations: Optimize temperature 37°C. Range of growth tolerance between 15°C and 40°C No growth at 10°C or 45°C. Does not sur-

NaCl and does not tolerate 6.5 per cent NaCl Final pH in glucose broth 4.2 to 4.6, no growth at pH 9.6. Methylene blue 0.01 per cent and 0.1 per cent not

cent hile.

Action on blood: Variable; between and of the strains produce a narrow clear cone of hemolysis; certain strains described as producing greening. The hemolytic strains produce an oxygenstable, filterable hemolytis.

Toxin: No evidence of an erythrogenie toxin.

Fibrinolysin, Does not dissolve human fibrin.

Serology Group B of Lancefield (Jour. Exp. Med., 47, 1933, 571). Three antigenic types have been separated which appear to be associated with the earbohydrate and not the protein fraction.

Facultative anaerobe.

Source: Isolated from milk and tissues from udders infected with mastitis. Occasionally reported from human sources (Lancefield, Jour. Exp. Med , 57, 1933, 571 ; Hare, Jour. Path. Bact., 41, 1935, 499). Habitat . Udder of cattle with mastitis.

6. Streptococcus sallvarlus Andrewea and Horder. (Lancet, 2, 1906, 712; Streptococcus cardio-arthritidis Small, Amer. Jour. Med Sci. 173, 1927, 103.) From Latin salivarius, slimy, clammy; M. L., related to saliva.

Description based on studies by Safford. Sherman and Hodge. Jour. Bact., 53. 1937, 263 and Sherman, Niven and Smiley, Jour. Bact., 45, 1943, 249.

Spherical or ellipsoidal cells, 0.6 to 08 micron in diameter, usually in short chains. Long axis of cell lies in axis of chain. Cells are relatively large in liquid media, especially milk. Gram-positive.

Gelatin stab: Filiform growth. No liquefaction

Plain nutrient agar, Colonies white, small, not more than 0.5 mm in diameter. Notwithstanding rather vigorous growth on artificial culture media, cultures die out readily.

Nutrient agar containing 5 per cent sucrose or raffinose produces a large, elear, soft, mucoid colony about the diameter of those produced by coliform bacteria and yeasts. This is quite distinctive as no other known species of streptococcus (except occasional strains of Streptococcus boris) produce colonies of this type on sucrose or raffinose ngar. The polysaccharide produced is a soluble levan, some strains producing in addition a smaller amount of insoluble dextran (the polysaccharide in the Streptococcus bovis colonies is a dextran).

Action on blood agar: Indifferent (gamma hemolysis of Brown, Rockefeller Inst. Med. Res., Monograph 9, 1919, 8). No soluble toxin and no hemolysin has been demonstrated

Broth: Variable. Loose, flocculent deposit with clear supernatant fluid and long chains, or uniform or granular turbidity with small deposit and short chains. No pellicle.

Litmus milk: Acidified and curdled promptly by all lactose-fermenting strains. Completely reduced but only after curdling. No digestion.

Potato: Slight growth. Difficult to detect.

Acid from glucose, maltose, sucrose, raffinose, inulin and salicin. No seid from glyecrol, mannitol, sorbitol, arabinose or xylose. Trchalose and lactose usually fermented.

No hydrolysis of sodium hippurate and arginine. Splits esculin. Starch is not

bydrolyzed. Ammonia is not produced from peptone

Chemical tolerance: Tolerates 2 per cent but not 4 per cent NaCl. Final pri in glucose broth between 4.4 and 40 No growth at pH 9.6. Methylene blue 0 01 per cent and 0.1 per cent not tolerated. Not soluble in bile but inhibited by 30 per cent bile in blood agar.

Catalase not produced.

Temperature relations: growth 37° to 43°C. Growth at 45°C. No growth at 47°C. No growth at 10°C. Does not survive 60°C for 30 minutes

Facultative annerobe.

Serology: No group antigen has been demonstrated. Contains several serological types.

Source. Saliva and sputum in various pulmonary infections, apical abscesses of teeth, carious lesions of teeth, intestinal tract.

Habitat: Human mouth, throat and nasopharynx.

gestion.

7. Streptococcus mitis Andrewes and Horder. (Lancet, 2, 1906, 712 ) From Latin mitis, mild

Synonyms: Streptococcus milior seu viridans Schottmuller, Munch Wehnschr, 50, 1903, 849 (these names refer to a group of species and they are therefore confused in meaning in medical literature. See Winslow and Winslow, The Systematic Relationships of the Coccaceae. New York, 1908, and Safford, Sherman and Hodge, Jour Bact , 33, 1937, 263). The name Streptococcus mitis was first proposed by Frankel (Munch med Wchnschr , 52, 1904, 548 and 1868) cause others have used this name with varied meanings (Streptococcus mitis seu viridans von Lingelsheim, in Kolle and Wassermann, Handb d path Mikroorg, 2 Aufl., 4, 1912, 453; Streptococcus mitis Holman, Jour. Med. Res., 54, 1916, 377), the more definite emendation of Andrewes and Horder has been used as the basis of the description given here relationships of these organisms has been discussed by Brown, Rockefeller Inst Med. Res , Monograph No 9, 1919, 86

Description based on studies by Safford, Sherman and Hodge (loc. cit ) and Sherman, Niven and Smiley, Jour Bact,

45, 1943, 249.

Spherical or ellipsoidal cells, 06 to 08 micron in diameter Long axis of cell lies in axis of chain. Cells not especially large in liquid media including milk. No capsules Gram-positive.

Gelatin stab: Filiform growth, No

liquefaction.

Nutrient agar: Growth increased when serum or blood is added Confluent growth, gray and abundant.

Action on blood agar. The colonies are surrounded by a characteristic greening (alpha hemolysis of Brown, Rockefeller Inst. Med. Res., Monograph 9, 1919, 8). This is weak with some strains and is variable under anaerobic conditions. No soluble toxin and no hemolysin has been demonstrated.

Broth: Variable. Loose, flocculent de-

posit with clear supernatant fluid and long chains, or granular turbidity with small deposit and short chains. No pellicle

Litmus milk. Usually acidified and eurdled promptly; litmus is completely reduced but only after curdling, no di-

Potato. Slight growth which is difficult to detect.

Acid from glucose, maltose, lactose, sucrose and usually salicin. Variable fermentation of raffinose. No acid from inulin, mannitol, sorbitol, glycerol, arabinose or xylose Trehalose rarely fer-

mented No hydrolysis of sodium hippurate and usually no hydrolysis of arginine Action

Usually ammonia is not produced from peptone.

Chemical tolerance. Tolerates 2 per cent but not 4 per cent NaCl Final plf in glucose broth 58 to 42, ave. 45 No growth at pH 96 Methylene blue 0.01 per cent and 0 I per cent not tolerated Not soluble in bile but inhibited by 30 per cent bile in blood agar

Catalase not produced

on esculin usually negative

Temperature relations Optimum growth 37° to 40°C Many strains do not grow at 45°C. No growth at 10°C Does not survive 60°C for 30 minutes.

Facultative appendix

Serology: No group antigen has been demonstrated Contains several serological types

Source. Saliva and sputum in various pulmonary infections, pus from upper respiratory tract and sinuses, blood and various organs in sub-acute endocarditis. Habitat Human mouth, throat and

nasopharvax

8 Streptococcus boyls Orla-Jensen emend. Sherman (Orla-Jensen, The Lactic Acid Bacteria, 1919, 137 : Sherman. Bacteriological Reviews, 1, 1937, 57.) From Latin bos, cow.

The majority of the strains of Strepto-

coccus inulinaceus may be considered as identical with Streptococcus boris as described here. The so-called Bargen streptococcus (Bargen, Jour. Amer. Med. Assn., 88, 1924, 332; Arch. Int. Med., 45, 1930, 559) is also considered to be Streptococcus boris.

Spheres: Occurring in pairs and chains. Capsulated in milk. Gram-positive.

Gelatin stab: Nn liquefaction.

Litmus milk: Acid, curdled in 3 to 5 days, followed by reduction of the litmus.

Acid from glucose, fructose, mannose, galactose, maltose, lactose, sucrase, raffinose and salicin; sometimes from mannitol, sorbitol, inulin, arabinose and trehalose. Not from glycerol.

Starch is hydrolyzed by typical strains but not by variety inulinaceus. Esculin is hydrolyzed but not sodium hippurate.

Nitrites not produced from nitrates.

Ammonia not produced from 4 per cent

peptone.

Temperature relations: Optimum temperature 35°C When freshly isolated, maximum 45°C. No growth at 22°C or below Survives 60°C for 30 minutes, but not 65°C.

Chemical tolerance: 2 per cent NaCl growth, 4 per cent NaCl no growth, 65 per cent NaCl no growth. Final pH in glucose broth 45 to 4.0. No growth nt pH 96 May tolerate 001 per cent methylene blue but not 0.1 per cent. Tolemnt of bile and not soluble.

Action on blood: Not hemolytic; the changes exhibited vary from greening (alpha) to no observable change (gamma). Soluble hemolysin: Absent.

Toxin: Absent.

Serology: Some cross reaction with

Lancefield Group D (Sherman, Jour Bact, 35, 1938, 81).

Facultative anaerobe.

Distinctive characters: Greening ar an change in blood, a higher maximum temperature of growth than Streptococcus saltarius and distinctly higher thermal resistance (60°C for 30 minutes); hydrolysis af starch and usually forments arabinose and sometimes mannitol.

Source: Saliva, feces and intestinal contents of entile; milk of cows; sometimes nhundantly present in human feces (Bargen's coccus) in health and disease. The variety inulinaceus is sometimes abundant in the bovine throat.

Habitat: Bovine mouth and alimentary tract where it is the predominating strep-

tocoecus.

9. Streptococcus thermophilus Orla-Jensen. (Maclkeri-Bacteriologi, 1916, 37; The Lactic Acid Bacteria, 1919, 136.) From Greek thermus, heat; philus, loving.

Spheres: 0.7 to 0.9 micron, with pointed ends, occurring singly and in short chains.

Gram-positive.

Gelatin stab : No liquefaction.

Nutrient agar: Small, pin-point, gray, circular colonies. In streak cultures growth is scanty, beaded and gray. Fastidious in nutritive requirements needing propriate carbohydrates added to pertono-infusion media (especially lactose and sucrose). Viability on laboratory media low.

Broth: Fine granular sediment; usunlly in very long chains, especially at

45°C.

Litmus milk · Acid, curdled, followed by partial reduction of the litmus.

Acid from glucose, fruetose, laclose, and sucrose; seldom ferments raffinose and arabinose. No acid from maltose, dextrin, inulin, glycerol, mannitol, sorbitol or salicin.

No hydrolysis of sodium hippurate or esculin. Starch may be hydrolyzed on a

favnrable medium.

Ammunia not formed from 4 per cent peptone.

Temperature relations: Optimum 40° tn 50°C. Minimum 20°C. No growth nt 53°C. Survives 60° and 65°C for 30 minutes. Thermal death point 72° to

74°C.
Chemical tolerance: Extremely sensitive to salt, no growth with 2 per cent, 4 per cent, and plf in glucose broth 4.5 to 4.0. No growth

at pH 96. Not tolerant of 001 per cent and 0.1 per cent methylene blue.

No action on blood

Serology. No cross reaction with Lancefield Group D (Sherman, Jour Bact, 35, 1938, 81).

Facultative anaerobe.

Distinctive characters High growth temperature (50°C) and heat resistance (60° to 65°C). Inability to ferment maltose and salicin. Inhibited by 2 per cent NaCl Nutritive requirements in medium

Source: Milk and milk products Used as a starter in making Sa iss cheese

10. Streptococcus equinus Andrewes and Horder. (Lancet, 2, 1906, 712) From Latin equinus, of horses.

Spheres: Occurring in short chains, the chains are longer in broth than in milk and some cultures give extremely long chains in broth. Gram-positive.

Gelatin stab: Little or no growth at 20°C. Not liquefied.

Litmus milk: No visible change, grows

poorly (with 2 per cent added glucose there is little reduction of litmus). Acid from glucose, fructose, galactose, maltose and usually from sucrose and

mattose and usually from sucrose and salicin; raffinose and inulin are seldom fermented; arabinose, vylose, lactose, mannitol and glycerol are not fermented. The salicin negative strains correspond to Streptococcus ignaeus Holman, Jour. Med. Res., 34, (N. S. 29), 1910, 377

Starch is not hydrolyzed under ordinary conditions of test (poured plate); it may be hydrolyzed by streak cultures on a very favorable medium. Sodium hippurate is not split. Esculin is bydrolyzed sloaly, failure in three days, becomes positive in seven

Ammonia not produced from 4 per cent

Temperature relations: Minimum 21°C. Growth at 45°C, seldom at 47°C, and no growth at 48°C. Sometimes survives 60°C for 30 minutes.

Chemical tolerance: Growth in 2 per cent NaCl but not in 4 per cent and 6.5 per cent. Final pH in glucose broth 4.5 to 4.0; no growth at pH 9.6. Some strains tolerate 0.01 per cent but none tolerate 0.1 per cent methylene blue.

Action on blood. Greening (alpha on home blood) varying to weak but definite No hemolysis Serology unknown, but no cross reac-

Serology unknown, but no cross reaction with Lancefield Group D (Sherman, Jour. Bact., 35, 1938, 81).
Facultative anaembe.

Distinctive characters: Minimum temperature of growth (20°C) and high maximum temperature of growth (47°C); poor growth in milk, even with added glucose; failure to ferment Luctose

Sources. Human and bovino feces; human mouth, urine and inflammatory exudates (pathogenieity not established). Andrewes and Horder (loc cit.) failed to find it in feces of fox and stoat.

Habitat: Predominating organism in the intestine of horses.

11. Streptococcus lactis (Lister) Löhnus (Bacterium lactis Lister, Quart. Jour Miero. Sci., 13, 1873, 380; 18, 1878, 177, Löhnis, Cent f Bakt, II Abt, 22, 1999, 553) From Latin lac, milk.

The following organisms are generally regarded as identical with Streptoceccus lactis Löhnis See Breed, in Jordan and Falk, The Newer Knowledge of Bacteriology and Immunology, Chicago, 1928,

383 Streptococcus acidi lactici Grotenfelt. Fortschr. d Med., 7, 1880, 121; Micrococcus acidi paralactici Neneki and Sieber, Monatsehr, f. Chem., 10, 1889, 532; Bacillus No 19, Adametz, Landw. Jahrb., 18, 1889, 227; Eine bestimmte Bacterienart, Günther and Thierfelder, Arch. f. Hyg., 25, 1895, 161; Bacillus acidi Jactici Taten, Storrs Agric. Exper. Sta. Conn , Ann Rep for 1896, 1897, 44 (not Milebaiurebaeterium, Hueppe, Mitt. d. Lais. Cesundheitsamte, 2, 1881, 310, which is Bacillus acidi lactici Zopf, Die Spaltpilze, 3 Aufl., 1885, 87); Bacterium guntheri Lehmann and Neumann, Bakt. Diag., 1 Auf., 2, 1896, 197; Bacterium

lactis acidi Leichmann, Cent. f. Bakt., II Abt., 2, 1896, 777 (not Bacterium lactis acidi Maromann, Erganzungshefte Cent. allgem. Gesundheitspflege, 2, 1896, 117); Der ovaler Coccus, Freudenreich, Cent. f. Bakt., H Abt , 1, 1896, 168; Bacillus lacticus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 356; Bacterium lacticus Chester, Del. Agr. Evp Sta., 9th Ann. Rept., 1897, 88; Bacillus acıdi paralactici Kozai, Ztschr. f. Hyg., 31, 1899, 372; Streptococcus paralacticus Migula, Syst. d. Bakt., 2, 1900, 18; Bacterium lacticum Migula, Syst. d. Bakt , 2, 1900, 405, Bacterium truncatum Migula, Syst. d Bakt , 2, 1900, 407 (Bacillus No. 19 of Adametz: Bactersum punctatum Chester, Man. Determ. Baet., 1901, 147; not Bacterium truncatum Chester, soid, 157; not Bactersum truncatum Chester, ibid., 195); Streptococcus grotenfeltin Chester, Manual Determ. Bact , 1901, 67; Lactococcus lactis Beijerinek, Arch. Neérl. d. Sci. Exact et Nat , Sér. II, 7, 1991, 213; Streptococcus lacticus Kruse, Cent. f. Bakt., I Abt., Orig , 34, 1903, 737, Streptococcus guntheri Lehmann and Neumann, Bakt. Diag , 4 Aufl , 2, 1907, 242; Bacillus lactis acidi Senerin, Cent. f. Bakt., II Abt., 22, 1908, 8 (not Bacillus lactis acidi Marpmann, loc cit, 120, nor Leichmann, loc. cit, 778), Bacterium leichmanni Wolff, Cent. f. Bakt , II Abt., 24, 1909, 57.

Spheres. Many cells elongated in direction of chain; 0 5 to 1 micron; mostly pairs and short chains, with some cultures long chains. Gram-positive.

Gelatin stab: Filiform to beaded growth. No liquefaction

Nutrient agar colonies: Small, round or oval, gray, entire, slightly raised Streak culture tends to remain as definite colonies throughout, confluent in parts

Glucose broth Turbidity and later sediment

Potato: No visible growth.

Litmus milk . Acid , complete reduction of litmus before curdling. Young cultures

entirely reduced with narrow red band at top which widens with ageing. No digestion and no gas produced, but whey may be expressed.

Acid from glucose, maltose and lactose; variable in arabinose, xylose, maltose, sucrose, mannitol and salicin. No acid from raffinose, inulin, glycerol or sorbitol. Occasional strains have been noted which fail to ferment lactose (Yawger and Sherman, Jour. Dairy Sci., 20, 1937, 83) and others which do ferment raffinose (Orla-Jensen and Hansen, Cent. f. Bakt., II Abt., 86, 1932, 6).

Starch not hydrolyzed. Sodium hippurate may be hydrolyzed and esculin is

Ammonia is produced from 4 per cent peptono.

Temperature relations: No growth at 45°C. Some strains survive 69°C for 30

Chemical tolerance: Growth with 2 per cent and 4 per cent NaCl hut not with 6 5 per cent. Final pH in broth 4 5 to 40 No growth at pH 9.6 but grows at pH 9 2 Tolerates both 9 01 per cent, 0.1 per cent and 03 per cent methylene blue. Bile neither lyses nor inhibits growth.

Action on blood: No hemolysis; may show greening or no action.

Serology: Sherman, Smiley and Niven (Jour. Dairy Sci., 23, 1940, 529) have produced a species-specific group serum for this species. Shattock and Mattick (Jour. Hyg., 43, 1943, 173) have designated this group as Group N. The above authors are in agreement in feeling that their studies indicate a close serological relationship between Streptococcus lactis and Streptococcus cremoris. Toxin not known.

Facultative anaerobe.

Distinctive characters: Growth at 10°C or below and at 40°C but not at 45°C; rapid complete reduction of litmus before curdling milk; growth in presence of 4 per cent but not 6.5 per cent NaCl; ammonia produced from peptone; no growth at pH 96 but grows at pH 92.

Source: Isolated from milk by Lister (loc. cit.). Milk and milk products

Habitat. Not in the udder of cows. Plants may be natural habitat (Stark and Sherman, Jour. Bact., 30, 1935, 639).

Nors: The following may be regarded as varieties of Streptococcus lactus: (1) Streptococcus lactus: (2) Streptococcus lactus var. maltigenes Hammer and Cordes, Iows Agr Exp Sta Res Bull. 68, 1921; (2) Streptococcus lactus var anoxyphilus Hammer and Baker, Iowa Agr. Exp Sta. Res. Bull. 99, 1926; (3) Streptococcus lactis var. tardus Hammer and Baker, ibid Also (4) Streptococcus and sompleadis, (5) Streptococcus refinolactus and (6) Streptococcus saccharolactus Orbi-Jensen and Hansen, Cent. f Bakt, H Abt., 68, 1932. 6.

Streptococcus cremoris Orla-Jensen. (The Lactic Acid Bacteria, 1919, 132.)
 From Latin cremor, thick juice, M. L., cream.

Synonyms: ? Streptococcus hollandacus Wigmann, in Kramer, Die Baktersologie in ihren Beziehungen zur Landuurtschaft und den Landu. Technischen Gewerben, Wien, 1809, Streptococcus ladits B. Ayers, Johnson and Mudge, Jour. Inf. Dis., 34, 1934. 20.

Spheres: 0 6 to 0 7 micron (often larger than Streptococcus (actis), forming long chains, especially in milk, some cultures in pairs. Gram-positive.

Gelatin stah: No liquefaction

Litmus milk. Acid, complete reduction of litmus before curding with red line at top broadening with age; clot separates with no digestion of casein, milk becomes slimy.

Acid from glucose and lactose, may ferment maltose, salicin and rarely sucrose, raffinoso and mannitol Arabinose, xylose, sorbitol, inulin and glycerol are not fermented.

No hydrolysis of starch and sodium hippurate but sometimes esculin

Ammonia not produced from 4 per cent peptone.

Temperature relations: Optimum be-

low 30°C. Minimum 10°C. Maximum 37°C. May survive 60°C for 30 minutes. Thermal death point 65°C to 70°C.

Chemical tolerance Grows with 2 per cent but not with 4 per cent and 6 5 per cent NaCl. Final pH in glucose broth 4 6 to 4 0 No growth at pH 9 6 and 9 2. Tolerates 0 01 per cent and sometimes 0 1

Distinctive characters: Inability to grow at 40°C; reduction of litmus before curding milk; no growth in the presence of 4 per cent NaCl and at pH 9 2; does not grow well on artificial media.

Source Raw milk and milk products; commercial starters in butter and cheese factories. Not known from human and animal sources

The following may be regarded as varieties of Streptococcus cremors: (1) Streptococcus lactis var. hollanducus Buchana and Hammer, Iowa Agr. Exp. Sta. Res Bull 22, 1915, (2) Streptococcus manufocremors of 19.4-Jensen and Hansen, Cent. f. Bakt, 11 Abt., 86, 1932, 6.

13 Streptococcus faecalis Andrewes and Horder. (Micrococcus ovalis Eschericli. Dio Darmbakterien, Stuttgart, 1886, 89, Entérocoque, Thucrcelin. Compt rend Soc. Biol., Paris, 54, 1902, 10S2: Entergeoccus proteiformis Thiereelin and Jouhaud, Compt. rend. Soc. Biol , Paris, 55, 1903, 696; Andrewes and Horder, Lancet, 2, 1906, 708; Streptococcus faccium and Streptococcus glycerinaceus Orla Jensen, The Lactic Acid Bacteria, 1919, 139 and 140, Diplococcus enterococcus Neveu-Lemaire, Précis Parasitol Hum , 5th ed , 1921, 18, Streptococcus otalis Lehmann and Neumann. Bakt Diag , 7 Aufl , 2, 1927, 200 and 230; Streptococcus protesformis Hauduroy et al , Dict d Bact Path , Paris, 1937, 520) I'rom Latin faez, dregs, residue; M L feces, excrement; M L faccalis. fecal

Escherich reclassified his Micrococcus

Litmus milk · Acid; curdled, followed by reduction of litmus.

Acid from glucose, maltose, lactose, and usually salicin and trehalose Raffinose, inulin, sorbitol, arabinose, glycerol not fermented and mannitol and sucrose rarely fermented.

Starch not hydrolyzed. Sodium hippurate and esculin are hydrolyzed.

Ammonia is produced from 4 per cent peptone

Temperature relations: Growth at 10°C. Maximum 50°C. Survives heating for 30 minutes at 62 8°C and usually 65 6°C.

Chemical tolerance: Growth with 2 per cent, 4 per cent and 65 per cent NaCl. Final pH in glucose broth 4.5 to 4.0. Growth at pH 96. Tolerates 0.01 per cent and 0 1 per cent methylene blue.

Action on blood: Active hemolysis of beta type (horse, human and rabbit blood); persistent after 5 years culture on media without blood.

Toxin unknown. Non-pathogenic for mice, rabbits and guinea pigs

Serology · Lancefield's Group D (Sherman, Jour. Bact , \$5, 1938, 81).

Facultative anaerobe

Distinctive characters . Growth at 10°C and 45°C; beta hemolysis; failure to ferment sucrose and mannitol, resistance to 60°C for 30 minutes, tolerance of 01 per cent metbylene blue and 65 per cent NaCl.

Source Forty strains were isolated from spray process milk powder.

Habitat: Human intestine, milk and milk products.

\*17. Streptococcus anaerobius Krönig emend Natvig. (Kronig, Zent. f. Gyn. 1895; Natvig, Arch. f. Gyn., 1905, 76.) From Greek an, without, aer, air; bios, life; M. L., anaerobic.

Heurlin (Bakt, Unters. d. Keimgehaltses im Genitalkanale d. fiebernden Wöchnerinnen. Helsingfors, 1910, 122-127) recognizes the following varieties of Streptoanacrobius anaerobius S. vulgaris, S. anaerobius typ. vulgaris, S.

anaerobius gonoides, S. anaerobius (Wegelius No 28), S. anaerobius micros (Lewkowicz), and S. angerobius carduus

Description according to Prévot. Ann. Sei. Nat., Sér. Bot., 15, 1933, 180.

Spheres: Average size 0.8 micron, occurring in chains. Non-motile. Grampositive.

Gelatin: No liquefaction.

Semi-solid agar (Veillon): After 48 hours colonies 1 to 2 mm in diameter, very lenticular. Gas Agar slightly acidified.

Martin broth: Rapid growth. No turbidity. Sediment in 24 hours. Medium slightly acidified. Feeble production of gas. Slight fetid odor.

Martin glucose broth: Very abundant growth. Gas fetid, inflammable, no H.S Very marked acidification.

Peptone water: Abundant flocculent growth. Gas produced at expense of peptone. Medium not acidified. Neither indole nor H.S produced.

Meat and liver broth: Very abundant growth. Much gas produced which contains CO. and He.

Milk: No acid. No coagulation.

Cooked protein (egg white, meat, liver, fibrin and serum) not attacked. Fresh fibrin and fresh organs partially disiategrated with blackening, abundant gas, very fetid odor due in part to H.S.

Serum broth: Abundant gas and fetid odor.

Neutral red broth: Changed to fluorescent yellow. Acid from glueose, fructose, galactose,

sucrose and maltose Mannitol and arabinose sometimes fermented.

Optimum pH 6.0 to 8.0.

Temperature relations: Optimum 36° to 38°C. Grows at 26°C, but not below 22°C. Survives 5 minutes at 60°C or Killed in ten two minutes at 80°C minutes at 80°C.

Pathogenic.

Strict anaerobe.

Distinctive characters: Very peptolytic; gas produced in peptone water with Differs from destruction of the peptone

<sup>\*</sup> See footnotes, p. 308. Reviewed by Dr. Ivan C. Hall.

Streptococcus foctidus by being morphologically like a typical streptococcus. Differs from Streptococcus putridus by its physiology, bread crumb-like growth, and the production of gas in all media

Source: Isolated in cases of putrefactive gangrene; war wounds, uterus, lochia and blood in puerperal infections, appendicitis; pleurisy; and amniotic fluid Habitat: Mouth and intestines Cavities of man and animals, especially

the vagina. Can invade all tissues 18 Streptococcus foetidus (Veillon)

Prévot. (Micrococcus foetidus Veillon, Compt. rend. Soc. Biol. Paris, 45, 1893, 867: not Streptococcus foetidus Migula. Syst. d. Bakt , 2, 1900, 38; Prévot, Ann Sei Nat., Ser Bot., 15, 1933, 189 ) From Latin foetidus (better fetidus), stinking

Largo spheres: 08 to 10 micron, oceurring normally in short chains, also in tetrads, double or zig-zag chains. Nonmotile. Gram-positive

Gelatin: No liquefaction.

Semi-solid agar (Veillon): Slow growth At first punctiform: small colonies 1 to 1 mm in diameter, growing 1 to 2 cm below the surface, regular, thick, lenticular, opaque. Gas bubbles produced

Blood agar; Small brownish hemopeptic zone around the colonies No

truo hemolysis.

Martin broth. Poor growth No turbidity. Flakes form on wall of tube, but rapidly settle to the bottom Little or no gas. Very faint fetid odor.

Martin glucose broth. Good growth No turbidity. Gas fetid, inflammable

Meat and liver broth . Rapid, abundant growth. Abundant gas Strong fetal odor.

Milk: No acid. No coagulation.

Peptone water. Gas production feeble. Indole not formed. Neutral red broth changed to fluores-

cent vellow. Fresh organs become green, then

blacken. Much gus produced containing 11,S, later the organs are gradually disinfermentation. Cooked protein not attacked

Acid and gas from glucose, fructose, galactose and sucrose No acid from

lactose, maltose, arabinose, glycerol, mannitol, dulestel or starch.

tegrated; partial bioproteolysis and H-S

Temperature relations Optimum 36° to 38°C. Feeble growth at 26°C. No growth below 22°C. Killed in one hour at 60°C or in ten minutes at 80°C.

Optimum pH 65 to 80. Pathogenic for guines pigs and mice

Strict anaerobe.

Common in fetid suppurations and autogenous gangrenous processes.

Source. First isolated from a fatal case Ludwig's angina Perincohritie phlegmon; the fotid pus from Bartholin's gland, gangrene of the lung; appendicitis.

Habitat Mouth, intestine and vagina of man and animals.

18a Streptococcus foetidus var buccalis (Linen Mierococeus der Mundhohle, Ozaki, Cent f. Bakt., I Abt., Orus . 76, 1915, 118; Micrococcus bucealis Bergey et al., Manual, 1st ed , 1923, 69, Prévot, Ann Sci. Nat., Sér. Bot., 15, 1933, 193 ) I'rom mouth

19 Streptococcus putridus Schottmuller emend. Prévot (Schottmuller. Mitteil a d Grenzgeb d. Med Chlrurg . 21, 1910, 450, Prévot, Ann. Sei Nat, Sér Bot , 15, 1933, 170, 181 ) From Latin putridus, rotten, decayed

Synonym Streptococcus putrificus Schottmüller, Münch med Wochnschr., 68, 1921, 662

Spheres Average size 08 micron, oc-

curring in chains. Gram-positive. Gelatin: No Inquefaction

Semi-rolid agar (Veillon): More or less lenticular, colonies I to 2 mm in dameter. No gas produced.

Blood agar A blackish-brown hemopeptie zone is produced around the colonies, with fetid gis (HS). Colonies become brownish, sometimes blackish.

Martin broth: In 6 to 8 hours uniform

turbidity which does not precipitate completely. No gas. Little odor.

Martin glucose broth: Rapid nbundant growth. Uniform turbidity. Sediment. No gas. Slight fetid odor. Black pigment in the sediment.

Meat and liver broth: Very abundant growth, very marked putrid odor. Incomplete sedimentation.

Peptone water Sparse growth. Neither gas, odor, H<sub>2</sub>S nor indole.

Milk: No acid No coagulation. Cooked protein not attacked.

Deep blood agar Agar is broken by the gas (H2S).

Fresh blood broth Abundant gas which contains a large amount of H<sub>2</sub>S. Blood blackens rapidly, has typical putrid odor

Fresh fibrin broth: The fibrin is broken up and partially digested.

Neutral red changed to fluorescent yellow.

Lead media blackened.

Acid from glucose, fructose and maitose Acid sometimes produced from sucrose, mannitol and galactose

Optimum pH 7.0 to 8 5.

Temperature relations: Optimum 30° to 38°C. Growth feeble at 28°C. No growth below 22°C. Killed in ten minutes at 80°C

Pathogenic when grown in media with fresh tissue and body fluids

Strict anaerobe.

Distinctive characters. Putrescence but absence of gas in ordinary media; presence of gas and H<sub>2</sub>S in media with fresh tissue or body fluids.

Source. Normal and fetid lochia, blood in puerperal fever, gangrenous appendicits, gangreno of the lung, in gas gargrene, gangrenous metastases; war wounds; osteomyelitis; and from annicit fluid. Found in sea water by Montel and Mousseron (Paris Médical, 1929)

Habitat: Human mouth and intestine and especially the vagina.

20. Streptococcus lanceolatus Prévot. (Coccus lanceolatus anaerobius Tissier,

Compt. rend. Soc. Biol. Paris, 94, 1926, 447; Prévot, Ann. Sci. Nat., Sér. Bot., 165, 1933, 173 and 193; not Streptocacu lanceolatus pasteuri nor Streptocecus lanceolatus Gamalela, Ann. Inst. Past. 2, 1888, 440; not Streptocaccus lanceolatus Saito, Arch. f. Hyg., 75, 1912, 121. Although Prévot's name is invalul, it is used until further comparative studies have been made. From Latin lanceolatu, having a little lance, pointed.

Large ovoid cells: 1.2 to 1.4 micross with pointed ends, occurring in short chains in culture and in pairs in evudates. Non-motile. Gram-positive.

Gelatin: No liquefaction.

Deep agar colonies: Very large, leaticular. Abundant gas produced which breaks up the medium.

Peptone broth: Uniform turbidity-Granular, glairy sediment.

Peptone water: Good growth Gas

Milk: No change.

Protein not attacked.

Hydrolyzed albumen reduced to CO., (NH.):CO; and NH;.

Acid from sucrose, glucose and starth No acid from lactose. (Butyrio, valennnic and acetic acid are produced, in the proportions 2:1:trace, from glucose and sucrose.)

Non-pathogenic for laboratory animals. Optimum temperature 37°C.

Strict anaerobe.

Distinctive characters: Proteolyte and saceharolytic; produces anmoon from hydrolyzed proteins; butyric, valerianic and acetic acid produced from hexoses. No H<sub>2</sub>S produced.

Source: From human feces in a case of

Habitat: Putrefying materials.

21. Streptocoecus micros Prévot (Streptococcus anaerobius micros Levie wicz, Arch. Méd. Exp., 35, 1901, 615; Prévot, Ann. Sci. Nat., Sér. Bot., 15, 1933, 193; afos ece Weiss and Mercado, Jour. Inf. Dis., 82, 1933, [81.) From Grek micrus, small (old spelling, micro).

Very small spheres: 0.2 to 04 micron, occurring in long chains or in pairs motile. Gram-positive

Gelatin: Poor growth No Lauefaction

Semi-solid agar (Veillon) · Slow growth; colonies at first punctiform, becoming lenticular and later forming proceases into the medium. Average size 0.5 to 1.0 mm in diameter, some reach 2 to 3 mm growing 2 or 3 cm below the surface.

Blood agar: No hemolysis No hemo-

pentolysis.

Martin broth; Slight particulate turbidity which slowly settles

Meat and liver broth: Rapid growth

Abundant sediment.

Peptone water: Powdery sediment Medium not acidified. No indole formed Neutral red broth: Changed to fluores-

cent yellow. Milk: Grous with difficulty. No acid

No congulation.

Acid produced rapidly from glucose, fructose, galactose, sucrose and maltose. No acid from lactose, arabinose, glycerol, mannitol, inulin and starch.

I'mtein not attacked.

Optimum pli about 70.

Optimum temperature 36° to 35°C No growth at 22°C. Killed in a quarter of an hourat 60°C.

Non-rathogenic for mice.

No toxin and no hemolysin.

Strict anacrobe.

Distinctive characters Neither gas nor fetid odor produced. Small size Source Gangrene of the lung, loches and uterus in puerperal sensis, ap-

pendicitis. Habitat: Mouth and intestine of man

and animals

22 Streptococcus parvulus Weinberg, Nativelle and Privot (Streptoceccus parculus non liquefaciens Repici, Compt rend Sec. Biol , Paris, 63, 1910, 528. Weinberg, Nativelle and Privot, Les Microbes Anaérobies, 1937, 1011, not Streptococcus parrulus Levinthal, Cent f Bakt., I Abt., Orig., 100, 1928, 195 ) From Latin partulus, very small, minute

Small anheres: Average size 0.3 to 0.4 micron, occurring in short chains, sometimes in pairs. Non-motile. Grampositive

Gelatin . At 37°C slow growth, culture at bottom of the tube; no gas No lique-

Deep glucose agar colonies: After 48 hours very tiny, lenticular, whitish. Old colonies become blackened. No gus produced.

Broth Rapid turbidity forms in 5 or 6 days as a whitish, mucous mass which clears the fluid No gas Faint disagreeable odor.

Indole not formed

Milk · Congulation in 2! hours

Egg white not attacked

Feebly attacks glucose and lactose. Dues not attack sucrose, galactose and dextrin

Optimum temperoture 37°C. No. growth at room temperature. Will grow at 41°C

Strict amerobe.

Distinctive characters Differs from Streptococcus micros by its black colonies. congulation of milk and its feeble saccharelytic power Differs from Streptococcus intermedius by its blick colonies. the smallness of its elements, feeble saccharolytic power and the viscous sediment in broth

Source Respiratory tract

Habitat Unknown.

Veillon and Repaci identified this organism as Streptococcus micros, but Weinberg, Nativelle and Prevot consider it as a distinct species, although rare

23 Streptococcus Intermedius Privot (Ann. Inst. Past., 39, 1925, 439.) From Latin entermedius, intermediate. Description taken in part from Privot.

Ann Sci Nat , Ser Bot , 15, 1933, 197. Spheres. 03 to 07 micron, very long chains In culture. Non-motile Grampositive.

Gelatin: Poor growth. No lique-

Semi-solid agar (Veillon): After 24 hours colonies 1 to 2 mm in diameter, regular, lenticular; sometimes with complex processes.

Blood agar: No change or slight greening.

Martin broth: Rapid growth. Uniform turbidity which slowly settles.

Martin glucose broth: Abundant growth. Abundant sediment. Medium strongly acidified.

Peptone water: Particulate sediment. Milk: Very acid. Congulated in 24 bours, without retraction of clot and not

peptonized.
Scrum broth (1:2). Rapid growth.
Congulation by acidification.

Proteins not attacked.

Neutral red brotb: Changed to fluorescent yellow.

Acid from glueose, fructose, galactose, malose and lactose. Acid from sucrose by some strains. Tho acid produced is lactic acid No acid from arabinose, glycerol, mannitol, dulcitol, inuln or starch.

Optimum pH 6 0 to 8.5.

Temperature relations: Optimum 36° to 38°C Poor growth at 26°C. No growth below 22°C. Killed in half analysis of 26°C at the property of 26°C.

hour at 70°C or in ten minutes at 80°C.

Pathogenic for guinea pigs and mice,
causing small abscesses: sometimes kills

in 48 bours.

No toxin and no hemolysin.

Strict anaerobe.

Distinctive characters: Strongly acidifies media Coagulates milk.

Source: Lochia and uterus in puerperal sepsis; gangrene of the lung; pleurisy; bronchiectasis; appendicitis.

Habitat: Human respiratory and digestive tracts and vagina.

24. Streptococcus evolutus Prévot. (Streptococcus Sch., Graf and Wittneben, Cent. f. Bakt., I Abt., Orig., SS, 1925, 443; Streptococcus Schwarzenbeck, Ford, Textb. of Bact., 1927, 455; also see Weiss

and Mercado, Jour. Inf. Dis., 62, 1938, 181.) From Latin evolutus, unrolled.

Description taken in part from Prévot, Ann. Sei. Nat., Sér. Bot, 15, 1933, 199.

Spheres: 0.7 to 1.0 micron, average 0.7 micron, occurring in pairs or in short and long chains. Pleomorphic. Often appear as short ovoid rods with rounded ends. Gram-positive.

Gelatin: Liquefaction.

Deep agar colonies: Lenticular or rosettes. Growth occurs about 1 cm beneath the surface; after a transfer the second generation may show a ring of growth in the middle of this sterile rose. This is the characteristic alternate roses appearance. Colonies usually become brownish with age.

Glucose broth: Abundant growth, resembling bread crumbs. Medium strongly acidified (pH 5). A small quantity of lactic acid produced.

Peptone broth: Rapid growth. No general turbidity. Precipitating floculent growth on the wall of the tube

Blood agar: No change, sometimes

Peptone water: Flocculent growth No turbidity. Indole not formed.

Litnus milk: Aeid. Curdled in 24 hours, clot retracts and fragments Slight peptonization with some straigs.

Strongly acid in glucose, fructose, galactose, sucrose, lactose and maltose Arabinose sometimes fermented.

Egg white not attacked.

Pathogenicity: Most strains not pathogenic, some produce slight local swelling subcutaneously with little pus in cuinea pigs and mice.

Optimum pH 6.0 to 8.5.

Optimum temperature 36° to 38°C.

No growth below 22°C.
Strict anacrobe at first, becoming facul-

tative with subsequent transfers.
Viability short aerobically and several

months anacrobically.
Distinctive characters: Growth is al-

ternate zones in agar. Strict anaerobe at first, later microaerophilic

at first, later microaerophilic Source: Skin abscess; appendicitis Habitat: Respiratory tract, mouth,

vagina.

Appendix I: Descriptions of poorly defined species, the taxonomic relationships of which are not clear-

 Streptococcus sp. Long and Bliss (Minute beta hemolytic streptococcus, Long and Bliss, Jour Exp Med, 60, 1934, 619; Long, Bliss and Walcott, 161d, 633)

Minute cocci, half to two-thirds the size of Streptococcus pyogenes, occurring singly, in pairs, sbort chains and in small and large masses. Gram-positive, but

may decolorize readily.

Blood agar: Very minute colonies 18 to 30 microns, aurrounded by a marked area of hemolysis (beta), easily visible before the colony is seen by naked eye, 4 to 10 times the diameter of the colony Under the microscopic colonies are finely granular, may appear wrinkled and crenated Colonies become visible after 48 to 90 thous incubation and relative area of hemolysis is 3 to 4 times diameter of colony

Gelatin. Not liquefied.

Glucose broth: Growth diffuse, abundant.

Litmus milk Not curdled, litmus not

Acid from glucose, maltose and sucrose, may or may not attack lactose, trebalose and saltein No acid from arabinose, raffinose, mulin, glycerol, mannitol or sorbital

Does not hydrolyze sodium hippurate and starch. Esculin is hydrolyzed

Ammonia is produced from peptone.

Temperature relations No growth at 10°C, very rarely growth at 45°C. Does not survive 60°C for 30 minutes.

Chemical tolerance Does not tolerate 65 per cent NaCl Final pll in glucose broth 54 to 46; no growth at pH 9.6 Methylene blue 01 per cent not tolerated No growth on 40 per cent bile-blood agar Action on blood: Hemolysis marked hefore colony is visible. May not produce soluble hemolysin by ordinary methods but does so a bundantly by appropriate methods.

Fibrinolysin: No solution of human fibrin.

Serology: Constitutes Group F of Lancefield and Hare (Jour Exp Med, 61, 1935, 335) Four serological types within the group (Bliss, Jour Bact, 53, 1937, 625).

Aerobe, facultative anacrobe,

Source. Human throat in bealth and disease, accessory sinuses, abscesses, vagina, skin and feces

Habitat: Iluman upper respiratory tract

2 Streptococcus sp. Long and Bliss (Group II, Long and Bliss, Jour. Exp Med. 60, 1934, 633; Group G, Lancefield and Hare, Jour. Exp Med., 61, 1935, 346, Bliss, Jour. Bact, 53, 1937, 625)

Probably identical with Streptococcus anginosus Andrews and Horder (Lancet, 2, 1906, 712) but probably other serological types are included in this group (Sherman, Bacteriological Reviews, 1, 1937, 40)

Spheres: Gram-positive.

Gelatin Not liquefied.

Litmus milk. Acid, may be curdled, not reduced Acid from glucose, maltose, sucrose,

trehalose and saliein, usually acid from lactose, and may or may not from raffinose and glycerol. No acid from arabnose, multin, mannitol or sorbitol.

Sodium hipoprate usually not hydro-

lyzed May hydrolyze starch and esculin.

Ammonta is produced from peptone

Temperature relations: No growth at 10°C and usually not at 45°C. Does not survive 60°C for 30 minutes

Chemical tolerance: Does not tolerate 65 per cent NaCl. Final pH in glucose broth 60 to 46; no growth at pH 96 Methylene blue 0.1 per cent not tolerated. May grow on 40 per cent bileblood agar, growth in 10 per cent bile.

Action on blood: Hemolytic (beta) with o wider zone than minute beta hemolytic streptococcus. Soluble hemolysin formed.

Fibrinolysis: May dissolve human fibrin, certain strains strongly, others

weakly.

Scrology: Constitutes Laocefield's and Hare's Group G. Bliss (loc. cit.) has shown serological Types I and II within the group. May include serological Type 16 of Griffith (Jour. Hyg. 34, 1931, 542). Those resembling Streptococcus onginesus seem to form o homogeneous type; others seem unrelated to it. Aerobic, facultativo anacrobe.

Source. Human nose, throat, vagina, skin and feces in health. In human diseose in puerperal fever with staphylococcus. Throat of normal domestic onimols and in animal infections probably as socondary invaders.

Habitat: Human upper respiratory tract ond vagina. Possibly throat of domestic animals.

3. Streptococcus sp. Brown, Frost and Shaw. (Jour. Inf. Dis , 38, 1926, 381; Lancefield, Jour Exp. Med., 67, 1933, 571.)

Belongs to Lancefield Group E.

Gelatio: Not liquefied Litmus milk. Not curdled ond not reduced

Acid from glucose, lactose, trebalose and sorbitol; may form acid from sucrose. glycerol, mannitol and salicin. No acid from arabinose, raffinose or inulin.

No hydrolysis of sodium hippurate, may hydrolyze starch and esculin.

Ammonia is produced from peptone.

Temperature relations: No growth at 10°C and 45°C. Does not survive 60°C for 30 minutes

Chemical tolerance: Does not tolerate 6,5,per cent NaCl. Final pH in glucose Cent. 18 40 42; no growth at pH 96. 443; Streptdue 0.1 per cent not tolerated Textb. of F

and not reduced. No growth on 40 per cent bile-blood agar, nor on 10 per cent bile.

Action on blood: Very hemolytic; strains reported by Plastridge and Hartsell (Jour. Inf. Dis., 61, 1937, 110) weakly hemolytic, Streptolysin produced and outstandingly acid stable (Todd, Jour. Potb. and Bact . 59, 1934.

Fibrinolysin: No solution of human fibrin.

Serology: Lancefield Group E, some cross reaction with Group C.

Acrobe, facultative anaerobe.

Source: Certified milk: bovine udder. Habitot: Probably in udder and dairy products.

4. Streptococcus sp. Hare. (Group H, Hare, Jour. Path. and Bact., 41, 1935, 499.)

Spheres: Gram-positive.

Blood agar: Small colonies, 07 to 09 mm, smooth surface, greenish color tending to blocken, hard, almost gritty and adherent to the medium. Hemolysis seldom complete except on Brown's borse blood agar. Oo boiled blood agar defioite grecolng and so different from Groups E, Fand K.

Litmus milk: Not curdled and not reduced.

Acid from glucose, maltose, sucrose, raffinose and salicin; acid may be formed from lactose and trehalose. No acid from arabinose, inulio, glycerol, mannitel of sorbitol.

No hydrolysis of sodium hippurate and starch, but may hydrolyze esculin.

Ammonia may or may not be produced from peptone.

Temperature relations: No growth at 10°C. Growth at 45°C. May survive 60°C for 30 minutes.

Chemical tolerance: Does not tolerate 6.5 per cent NaCl. Final pll in glucose broth 5.0 to 4.5; no growth at pli 96 Methylene blue 0.1 per cent not tolerated No growth on 40 per cent bile blood agar.

Action oo blood: 11cmolysis incomplete

and sorce greening. No soluble bemoiysin. Fibrinolysin: No solution of human

fibrin.

Scrology: Group H.

Aerobe, facultative angerobe Source: Human throat and feces Habitat: Human throat.

5. Streptococcus sp. Hare K. Hare, Jour. Path, and Bact, 41, 1935, 499 )

Spheres · Gram-positive.

Blood agar: Colonies 08 to 13 mm, moist and transparent, with crenated edges. Incomplete bemolysis and no alpha prime appearance.

Acid from glucose, lactose and saliem; may form said from trabalose (doubtful) No acid from mannitol or sorbitol-

Does not hydrolyro sodium hippurate. Chemical tolerance: Final pH in glucose broth 51 to 54 Does not grow on 16 per cent and 46 per cent bile-blood agar.

Action on blood: Incomplete hemolvsis: does not produce soluble hemolysm. Doubtful if truly heroolytic streptococcus.

Fibrinolysin: Does not dissolve buman fibrin.

Serology · Group K

Aerobe, facultative anaerobe.

Source: Human throat.

Habitat: Human throat No indication of relation to disease.

6 Streptococcus acidominimus Ayers and Mudge. (Ayers and Mudge, Jour Inf. Dis , 51, 1922, 40; 53, 1923, 155.) From M. L., derived to mean a roinimum amount of scul

Description taken from Smith and Sherman, Jour. Inf. Dis . 65, 1939, 30t Spheres: Generally occur in short chains. Gram-positive.

Gelatin stab: Filiform, beaded growth. No liquefaction.

Plain nutrient agar: Small round white colonies

Acid from glucose, lactose and sucrose. May form seid from maltose, trehalose, and mannitol. Sorbitol and salicin usually are not fermented. No acid from arabinose, xylose, raffinose, inulin and givcerol.

Sodium hippurate is hydrolyzed but not starch.

Carbon dioxide is produced from a 4 per

cent peptone-infusion broth. Litmus mulk: Little or no visible

change. Ammonia is not produced from

pentone.

Temperature relations: No growth at 10°G. A few cultures grow at 45°C. Do not aurvive 60°C for 30 minutes.

Chemical tolerance: No growth in 01 per cent methylene blue. Growth in 2 per cent but not in 65 per cent NaGl. Final pH in glucose broth 6.5 to 56 No growth at pH 96.

Action on blood: No hemolysis, slight greening (alpha).

Serology: Negative reaction serums representing Lancefield groups A. B. G. D. E. F and G.

Facultative anaerahe.

Distinctive character: Small amount of acidity developed in fermentation tests.

Source: Originally 12 cultures were isolated from freshly dmwn milk. Also found in bovine vagina, occasionally inthe udder, and on the skin of calves Habitat. Known to occur abundantly

in the boyine varina. The relationship between Streptococcus

uberia Diernholer and other similar streptococci is not yet entirely clear. Smith and Sherman (Jour. Inf. Dis., 65, 1939. 301-305) at one time thought that Streptococcus uberis and Streptococcus acidominimus might be identical. Others have regarded Streptococcus uberis as identical with Group III, Minett (Proc. 12th Internat. Vet Cong., 2, 1931, 511).

Brown (Proc. 3rd Internat, Cong. for Microbiol., 1940, 173) describes a new species, Streptococcus lentus (not Streptococcus lentus Lehmann, Deutsch. Arch f. klin. Med., 150, 1926, 144) which belongs to serological group E. He estates that a few strains that produced the alpha appearance in blood agar corresponded culturally with Streptocacus uberis.

Later Sherman (personal communication) had an opportunity to determine the serological group of several cultures of Streptococcus uberis carefully identified by R. B. Little and found them to belong to Group D. While their characters were not exactly the same as the conventional Streptococcus faccales, he feels that these cultures of Streptococcus ubers were only a variant type of Streptococcus faccalis.

Appendix II.\* The following species of streptococci are listed chiefly because of their historical interest. In many cases the original cultures are lost and their exact taxonomic relationships have not been determined.

Bacterium acetylcholini Habs. (Cent. f. Bakt., II Abt., 67, 1937, 194.) From ensilage. Regarded as a stable type of Enterococcus

Diplococcus bombycis Paillot. (Annales des Épiphytics, 8, 1922, 131.)
From the silkworm (Bombux mori).

Diplococcus liparis Paullot (Annales des Épiphyties, 8, 1922, 122) From larvae of the gypsy moth (Porthetria (Lymantria) dispar)

Diplococcus lymantriae Paillot. (Compt. rend. Acad Sci., Paris, 164, 1917, 526.) From larvae of the gypsy moth (Porthetria (Lymantria) dispar).

Diplococcus metolonthae Paillot. (Compt. rend. Soc. Biol., Paris, 69, 1917, 57; Annales des Épiplyties, 8, 1922, II3) From diseased larvae of cockchafers (Metolontha metolontha).

Diplococcus pierus Paillot. (Annales des Épiphytes, 8, 1922, 128.) From diseased caterpillars of the cabbage butterfly (Pierus brassicae).

Diplococcus scarlatinae sanguinis

Jamieson and Edington. (Brit. Med. Jour., 1, 1887, 1265) From the desquamation and blood of scarlet fever patients

Enterococcus citreus Stutzer and Wsorow. (Cent. f. Bakt., II Abt., 71, 1927, 117.) From normal pupae of a moth (Euroa secetum).

Lactococcus agglutinans Plevako and Bakushinskaia. (Microbiology (Russian), 4, 1935, 523; abst. in Cent. f. Bakt, II Abt., 94, 1936, 64.) Agglutinates haker's venst.

Streptobacillus malae Gaudby. (Jour. State Med. London, 50, 1922, 417; Streptococcus malae Thomson and Thomson, Ann. Pickett-Thomson Res. Lab., 5, 1929, 22.) From the mouth. An aberrant streptococcus.

Streptococcus abortus-equi Hauduroy et al. (Streptococcus abortus equi Ostertas, Monatsh. f. Tierheilk., 12, 1900, 38; Hauduroy et al., Dict. d. Bact. Path, Paris, 1937, 508.) From aborting mares

Streptococcus acidi-lactic Chester. Gphacrococcus acidi lactici Marpmann. Ergānzungsheft d allegemeine Gesundheitspflege, 2, 1886, 121; not Streptococcus acidi lactici Grotenfeldt, Fortschr d Med. 7, 1889, 124; Micrococcus lacticus Migula, Syst. d. Bakt., 2, 1000, 65; Chester, Man. Determ. Bact., 1901, 65) From fresh milk.

Streptococcus aerobius Heurlin. (Bakt-Untersuch. d. Keimgehaltes im Genitalkanale der fiebernden Wochnerinnen, Helsingfors, 1910, 60.) From the genital canal.

Streptococcus aerogenes Wirth. (Cent.f. Bakt., I Abt., Orig., 99, 1026, 200.) From buman blood. An aerobic species which produced gas in deep glucose agar.

Streptococcus aerophilus Trevism (I generie le specie delle Batteriacee, Milan, 1839, 31; not Streptococcus aerophilus Heutlin, Bakt. Untersuch d. Keimschaltes im Genitalkanale der fiebernden Wöchnerinnen, Helsingfors, 1910, 62) From air.

Prepared by Miss Eleanore Heist, July, 1938, revised by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, February, 1944.

Streptocaccus alactosus Smith and Brown. (Jour. Med. Res., 31, 1015, 455; Rockefeller Inst for Med. Res., Monograph 9, 1019; Streptocaccus haemolyticus 11, Holman, Jour. Med. Res., 34, 1916, 377) From human tonsillitis; peritoneal pus. See Manual, 5th ed, 1039, 332 for description of this speries.

Streptococcus albicans Migula. (Schminkeweisser Streptococcus, Tataroff, Inaug Diss., Dorpat, 1891, 69; Migula, Syst d. Bakt, 2, 1900, 22) From water.

Streptococcus albidus Henrici. (Arb. bakt. Inst. Karlsruhc, 1, Heft 1, 1894, 53.) From Cantal choese.

Streptococcus albus Sternberg. (Weisser Streptococcus, Muschek, Bakt. Untersuch. d Leitmeritzer Trinkwasser, Jahresber. d Oberrealschule zu Leitmeritz, ISS7; Sternberg, Man. of Bact., 1836, 610. Micrococcus albus Macé, Tmité pratique de Bact., 6th ed, 1912, 605.) From water.

Streptococcus allantoicus Barker. (Jour. Bact., 40, 1943, 251.) From black mud, San Francisco Bay.

Streptococcus alvearis (Preuss) Trevisan. (Cryptococcus alvearis Preuss, 1868; Trevisan, I generi e le specie delle Batteriacce, 1859, 31.) From an infection (foulbrood?) In bees.

Streptococcus ambratus Trevisan (Microcecce ambrate, Perroneito and Ajrolda, Giornalo d. r. Acead. d. Med. d. Torino, 48, 1885, 809; Trevisan, I generie le specie delle Batteriacce, 1889, 30.) From the respiratory fract of a lorse.

Streptococcus anhaemolyticus tulgaris Streptococcus anhaemolyticus culgaris Zangemeister, Münch, med Wochnschr., 67, 1910, 1268; Rolly, Cent f. Bakt, J. Abt, Orig., 61, 1912, 90). Synonym of Streptococcus aaprophyticus Mundelbaum (Ztschr. f. Hyg., 88, 1907, 37; see Broan, Morograph No. 9, Rockefeller Inst. Med. Res., 1910, 87). From vaginal secretions, milk and salva.

Streptococcus aphthicola Trevisan. (I generi e le specie delle Batteriacee, 1889,  From the lesions of foot and mouth disease of cattle.

Streptococcus aromaticus van Beynum and Pette. (Directie Landbouw. Verslag. Landbouwk. Onderzoek. 42, 1936, 360; also see Hoecker and Hammer, Jona Agr. Exp Sta. Res Bull. 200, 1941, 317 ) Produces diacetyl and small amounts of acetylmethylcarbinol in milk. From eream and butter.

Streptococcus articulorum Flugge. (Die Mikroorganismen, 2 Aufl, 1880, 183) Associated with diphtheria Trevsan (I generi e le specie delle Batteriacee, 1889, 30) considers this identical with Streptococcus diphteritieus Colm (Bettr. z Biol d. Pflunz., I, Heft 2, 1872, 162).

Streptococcus asalignus Frost, Gumm and Thomas (Jour. Inf. Dis., 40, 1927, 703) From milk.

Streptococcus aurantiacus Killian and Febér. (Ann. Inst Past., 55, 1935, 619.) From Sahara Desert soil.

Streptococcus bombyes Sartinna and Paccanaro. Cont. I. Bakt., I. Aht., Orig., 40, 1906, 331; probably not Streptococcus bombyeis Zopf, Die Spaltpilze, 2 Aufl., 1884, 62) From diseased silk worms (Bombye mori). According to Paillot (Les maladies du ver Asoe, Lyon, 1928, 171) this is the same as Streptococcus pastoransy Krassilstehik.

Streptococcus bonvicini Chester. (Streptococcus della leucaemia, Bonvicini, Cent f. Bakt, I Abt., 21, 1897, 211; Chester, Man. Determ. Bact., 1901, 59.) From a case of leucaemia in a dog.

Streptococcus borinus Trevisan, (Microeccus borinus Trevisan, Rendiconti Reale Inst. Lombardo di Sci. e Lett., Ser. II, 12, 1879; Trevisan, I genori e le spece delle Batteriacce, ISS9, 30; not Micrococcus bosinus Migula, Syst. d. Bakt., 2, 1909, 67, not Streptococcus bosinus Broadburst, Jour. Inf. Dis., 17, 1915, 321; not Streptococcus borinus Frost and Engelhrecht, The Streptococci, 1910, 56.) From luman throat; bovine, equine, feline and canine feces.

Streptococcus brens von Lingelsheim.

Streptococcus fermenti (Trevisan) Trevisan. (Microcaccus fermenti Trevisan, Batt Ital., 1879, 19; Micrococcus viscosus Flugge, Die Mikroorganismen, 2 Aufl., 1886, 172; Trevisan, I generi e le specie delle Batteriacce, 1889, 31.) From a slimy growth in wines.

Streptococcus fischeli Chester. (Mieroorganismus No. 2, Fischel, Ztschr. f. Heilkunde, 12, 1891, 7 and Cent. f. Bakt., 9, 1891, 611; Chester, Man. Determ. Bact., 1901, 59.) From the blood of in-

fluenza patients

Streptococcus foctidus Migula. (Stinkcoccus, Klamaun, Allegem, med, Centralzeitung, 1887, 1317; Diplococcus fluorescens foctidus Eisenberg, Bakt. Diag., 1801, 10, Migula, Syst. d. Bakt., 2, 1900. 38; Streptococcus fluorescens Chester, Man. Determ Bact., 1901, 70; Streptococcus fluorescens foetidus Miquel and Cambier, Tratté de Bact., Paris, 1902, 792 ) From eases of ozena

Streptococcus galleriae Chorine. (Compt rend Soc. Biol., Paris, 95, 1926, 201 ) From the bee moth (Galleria

mcllonclla)

Streptococcus genitalium Dimock and Edwards (Kentucky Agr Exp. Sta. Res Bull 286, 1928, 162.) Found com. . monly in the genital tract of marcs.

Streptococcus giganteus Migula (Streptococcus gigonteus urethrac Lustgarten and Mannaberg, Vierteliahrsschr. f Dermatologie u Syphilis, 1887, 918; Migula, Syst. d. Bakt , 2, 1900, 39.) From human urethra and from urine.

Streptococcus gingivae. (Quoted from Annals Pickett-Thomson Res Lab., 3, 1927, 154 ) From human gums and teetli. Streptococcus granulatus Henrici. (Arb. bakt Inst. Karlsruhe, 1, Heft 1, 1894, 55 ) From cream cheese.

Streptococcus haematosaprus Trevisan. (Mikrokokken der Fäulniss, Flugge, Die Mikroorganismen, 2 Aufl, 1886, 173; Trevisan, I generi e le specie delle Batterracee, 1889, 31.) From putrefying blood.

Streptococcus halitus Heim and Schlirf.

(Cent. f. Bakt., I Abt., Orig., 100, 1926, 39.) From deposit on the tongue.

Streptococcus havaniensis Sternberg (Man. of Bact., 1893, 612.) From acid vomit of a yellow-fever patient.

Streptococcus hemolyticus I, II and III Holman. (Jour. Med. Res., 54, 1916, 388.) From various human infections.

Streptococcus herbarum Schieblich. (Cent. f. Bakt., I Abt., Orig., 124, 1932, 269.) From green plant material. Motile. Related to Streptococcus lactis except it is flagellated. Kolbmuller (Cent. f. Bakt., I Abt., Orig., 155, 1935,

310) identifies this with Enterococcus. Streptococcus hydrophoborum Trevian (Streptococcus bei Rabies, Babes, Ztachr f. Hyg., 5, 1885, 184; Trevisan, I generi ele anccie delle Batteriacce, 1889, 30 ) From the brain in a case of rabies.

Streptococcus influentiae Trevisaa. (I generi e le specie delle Batteriacce, 1893, 30.) From equine influenza.

Streptococcus influenzos Thomson and Thomson. (Grippestreptokokkus, Seligmann, Cent. f. Bakt., I Abt , Ref., 50, 1911, SI; Thomson and Thomson, Monograph No. 16, Part I, Annals Pickett-Thomson Res. Lab., 1933.) Associated with influenza.

Holman. Streptococcus infrequent (Jour. Med. Res., 54, 1916, 383.) From various human infections.

Streptococcus kirchneri Chester. (Diplococcus, Kirchner, Ztschr. f. Ilyg, 9, 1890, 528; Chester, Man. Determ. Bact, 1901, 57.) From sputum in cases of influenza.

Streptococcus kochii Trovisan. (1 generi e le apecie delle Batteriacee, 1889,30)

From rabbit septicemia

Streptococcus lacteus Schröter. (Kryptogam. Flora v. Schlesien, 3, 1, 1886,

149.) From the air and dust. Streptococcus lactis oromaticus Joshi

and Ram Ayyar. (Indian Jour. Vet. Sci. 6, 1936, 141.) Possibly Streptococcus cremoris Orla-Jenson. From cream-

Streptococcus lactis innocuus Stolting (Inaug. Diss., Kiel, 1935, 16.) From ripening cheese.

Streptococcus logerheimii var. subterraneum Migula. (Hansgirg, Ocsterr. Zeitung, 1888, No. 7 and 8; Migula, Syst. d. Bakt., 2, 1900, 41.) From the wall of a wine cellar.

Streptococcus (Diplococcus) lanceolatus orum Gaertner. (Cent. f Bakt, l Abt., Orig., 54, 1910, 546.) From mastitis in

abeco

Streptococcus lapillus Heim and Schlif. (Cent. f. Bakt., I Abt., Orig., 100, 1926, 33) From the oral cavity

Streptococcus leutus Lehmann. (Lehmann, Deutsch, Archt. f. klin Med., 150, 1926, 144; Streptococcus pyogenes lentus, 101d., 141; not Streptococcus lentus Brown, Rept Proc. Third Internat. Congr. for Microbiol., New York, 1910, 173) From urino, cerviv, sputum and carnous teeth

Streptococcus libavienns Flatzek (Cent. f. Bakt., I Abt., Orig., 82, 1919, 210; Bocterium libariense Flatzek, idem.) From human seces. Motile.

Streptococcus lucae Trevisan. (Micrococcus ulceris mollis de Luca, 1836, Trevinin, I generi e lo specio delle Batteriacce, 1859, 30) From chancroidal ulcers

Streptococcus luteus Killian and Felict (Ann. Inst. Past, 55, 1935, 619) From Salara Desert soil.

Streptococcus magnus Henrici. (Arb. lrakt Inst. Karlsruhe, 1, Heft 1, 1804, 54) From Bric cheese

Streptococcus malaperti Trevisan (Mierococcus E, Malapert-Neuville, 1887, Trevisan, I generi e le specie delle hat teriacce, 1889, 30 ) From roineral water of hot springs at Schlangenland.

Streptococcus matignus Tresisan (Streptococcus progenes matignus 110gge, Die Mikroogsanismen, 2 Aufl, 1885, 183, Trevisan, I generi e le specie delle Batteriacce, 1883, 30 ) From a diseased spileca. Produby identical with Streptococcus pyogenes

Streptococrus mammitis boris Hutchens (Hutchers, in Besson, Pret. Bact Microbiol, and Scrum Therapy. Trans. of 5th ed., 1913, 613.) From mastitis in cattle

Streptococcus margaritaceus Behrüter.

(In Cohn, Kryptog. Flora v. Schlesien, 5, 1,1886, 149.) From putrefying blood.

Streptococus mathers Muslow (Green producing streptococus, Tunnielifi, Jour. Amer. Med. Assoc., 71, 1918, 1733; Mather's coccus, Jordan, Jour. Inf. Dis., 25, 1919, 30; Muslow, ibid., 31, 1922, 295.) From sputum in cases of influenza and pneumona

Streptecoccus maximus Weiss (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 180.) From a bean and carrot infusion.

Streptococcus melonogenes Schlegel. (Berl. tierarzt! Wochnschr., 1906, No. 25, 461) Produces grayish-yellow pigment in gelatin. Associated with a disease of horses

Streptococcus meningilidis Bonome, (Cent f Bakt., 8, 1800, 172 and 703) From exudates from cases of cerebrospinal meningitis

Streptococcus merdarius Trevisan. (Streptococcus des selles, Cornil and Babes, Bactérica, 2nd ed., 1886, 118, Trevisan, I generi e le specie delle Batteriacce, 1889, 31.) From feces.

Streptocecus microapoilia Cooper, Keller and Johnson (Amer Jour. Dis of Children, 47, 1031, 388 and 506; there authors also use the trinomial Streptooccus micro-apoilia enteritis ) From human throat and feese in enteritis in children. See Manual, 5th ed. 1939, 331 for description of this species.

Streptococcus rurobilis Roscoc and Lunt (Phil Trans Roy Soc, London, 152, 1832, 618)

Streptocorcus mixtus Bergey et al (Manual, 1st ed., 1923, 49.) From a variety of pyogenic inflammations.

Streptococus morbilli Perry and Fisher (Jour Amer Med Assoc, 8), 1926, 933.) From blood of perrons in early stages of messles

Streptecoccus morbillosus Trevisan, (Uicrococcus morbillosus Trevisan, Itanienti Italie Inst Loutardo di Sci. e Lett., Ser. II., 12, 1879; Trevisan, I generie e le specie delle Butternacce, 1883, 23). From human, canine and pretene neades.

Streptococcus murisepticus v. Lingels.

blood in cases of subacute bacterial endocarditis.

Streptococcus saprogenes Trevisan. (I generi e le specie delle Batterinece, 1889, 31.) From putrefying blood.

Streptococcus saprophyticus Mandelbaum. (Ztschr. f. Hyg., 58, 1908, 37.) See Streptococcus anhacmolyticus rulgaris From mucous membranes.

Streptococcus schmidti Trevisan. (Coccus bei Fadenziehende Milch, Schmidt-Mulheim, Arch. f. d. ges. Physiol., 27, 1882, 499; Trevisan, I generi o le specio delle Batteriacce, 1889, 31.) From ropy milk.

Streptococcus seiferti DeToni and Trevisan. (Micrococcus bei Influenza, Scifort, in Volkmann, Sammlung Klin. Vortrage, 240, DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1056.) From sputum and nasal secretions of influenza patients.

Streptococcus septicus Migula. (Streptococcus scritcus liquefans Babes, Bakt. Unter. u. septische Prozesse des Kindesalters, Leipug, 1889, 22; Streptococcus septicus liquefaciens Babes, according to Eisenberg, Bakt. Diag, 3 Aufl., 1891, 312; Migula, Syst. d. Bakt., 2, 1990, 27; not Streptococcus septicus Flügge, Dio Mikroorganismen, 2 Aufl., 1886, 154.) From the blood and organs of a diseased child. Streptococcus septiopamicus Biondi.

Streptococcus septopyaemicus Biondi. (Ztschr. f. Hyg., 2, 1887, 194 and 225.) According to Migula (Syst. d. Bakt., 2, 1900, 6) this is a synonym of Streptococcus pyogenes. From human saliva.

Streptococcus sornthalii (Adametz) Migula. (Micrococcus sornthalii Adametz, Cent. f. Bakt., II Abt., I, 1895, 465, Migula, Syst. d Bakt., 2, 1900, 20.) From milk and hard cheese.

Streptococcus sphagn: Migula. (Syst. d. Bakt., 2, 1900, 40.) From sphagnum in the Black Forest.

Streplococcus sputigenus Migula. (Syst. d. Bakt , 2, 1900, 24 ) From sputum.

Streptococcus stenos Bergey et al.

(Manual, 1st ed., 1923, 50.) From a variety of human inflammatory conditions
Streptococcus stramineus Henrich
(Arb. bakt. Inst. Karlsruhe, 1, Heft 1,
1894, 59.) From Schlosskäse.

Streptococcus subacidus Holman. (Jour. Med. Res., 54, 1916, 388.) From various human infections.

Streptococcus suspectus Trevisan. (Streptococco dell' ematuria, Pisiasangue' dei bovini; Trevisan, I generi ele specie delle Batteriacee, 1839, 30) From blood and spleen in cases of bovine hematuria.

Streptococcus tenuis Veillon (Arch Méd. Exp. et Anat., 6, 1894, 161.) From human mouth.

Streplococcus terricola van Steenberge. (van Steenberge, Ann. Inst. Past., 34, 1920, 806; not Streplococcus terricola Killian and Fehér, Ann. Inst. Past., 65, 1935, 619.) From garden soil.

Streptococcus toricatus (Burrill) De-Toniand Trevisan. (Micrococcus toricatus Burrill, The Bacteria. Illinois Industrial Univ., 11th Ann. Rept., 1882, 42; DeToni and Trevisan, in Saccardo, 81logo Fungorum, 8, 1889, 1065) From diseased plant tissue.

Streptococcus trifoliatus Migula. (Diplococcus ureae (non pyogenet) trifoliatus Rovsing, Die Blasenettuhausgen, ihre Aetiologie, Pathogenese und Behanglung, 1830, 43; Migula, Syst. d Bakt., 2, 1900, 29.) From cases of cystitis.

Streptococcus turbidus Lehmann and Neumann. (Bouillon trubende Streptokokken, Behring, Cent. f. Bakt. 12, 1826, 1933; Lehmann and Neumann, Batt. Diag., I Aufl., 2, 1806, 125.) From various human infections, especially crystelss Presumably a smooth culture of Streptococcus pyogenes.

Streptococcus tyrogenus Henrici. (Arb. Streptococcus tyrogenus Henrici. (Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 50)
From cheeses.

Streptococcus ureae Migula. (Streptococcus pyogenes ureae Roysing, Die Blasenentzündungen, ihre Actiologie, Pathogenese und Behandlung, 1803, 45; Mugula, Syst. d. Bakt., 2, 1903, 23, not Streptococcus ureae Trevisan, I generi e le specie delle Batteriacee, 1853, 31.) From esses of cystitis,

Streptococcus urinae Migula. (Diplococcus ureae (non pyogenes) Rovsing, loc cit., 45; Migula, Syst. d. Bakt, £, 1900, 13.) From cases of evatuts.

Streptecacus raccinae (Cohn) Zopf. (Microsphäeren der Vaccine, Cohn, Arch f path. Anat., 55, 1872, 237, Microsphaera taccinae Cohn quoted from Cohn, Berträge z. Biol, d Pflanzen, 1, 11eft, 2, 1872, 161; Microeccus raccinae Cohn, idem; Zopf. Die Spaltpilze, 3 Auf., 1885, 52) From lymph of cow pox pastules.

Streptococus raricellae Trevisan (Microbio della varicella, Bareggi, 1853, probibly in Gazz, Med. ital Lomb Milano, 220-212; Trevisan, I generi e le specie delle Datterlacec, 1839, 30 ) From chieken-pox pustules.

Streptococcus ranolae Trevisan. (Microsphideren der Varnola, Cohn. Arch f path Anat, 85, 1872, 287, Microsoccus 1 molae Colin, 1872, quoted from Trevisan, I genen e le specie delle Batteriacec, 1889, 30) From lymph of small pox putules. Regarded by Colin (Beiträge z Biol d Plannen, t, 1164 2, 1872, 161) as a variety of Microsoccus inceinae Cohn

Streptococcus ratiolae-orimae (Plant) DeToni and Trevisan. (Micrococcus ratiolae orimae Plant, Das organisate Contagium der Schaftpocken und die Mitigation deselben, Leipzu, 1822, DeTom and Trevisan, in Succardo, Sylloge Fungarum, 8, 1839, (1939) From the lymph in sheep por puttiles

Streptococcus termiformis Sternberg (Wurnformiger Streptococcus, Maschel, Bakt. Unters. d. Leitmeritzer Trinkwasser, Jahreab. d. Oberrealschule zu Leitmeritz, 1887; Sternberg, Man. of Bact., 1893, 611.) From water.

Streptococcus tersatilis Broadhurst. (Jour Inf. Dis., 17, 1915, 323) From throat of dogs, horse and cattle feces, etc.

Streptococus rini Migula. (Vicrococus aprogenes rini II, Kramer, Landwirtsch Versuchsstat, 37, 1800, 325 and Die Bakt. in ihren Bezichungen z Landwirtsch u. d. landwirtsch technisch. Gewerben, 8, 1802, 140; Migula, Syst. d. Bakt. 2, 1900, 33 ) From winc.

Steeplecoccus siecosus Lehmann and Keumann (Schleimiger Streptokohken, Behring, Cent. f. Bakt., 12, 1832, 193; Lehmann and Neumann, Bakt. Drug., 1 Aufl., 2, 1850, 125.) From various human infections. Presumably a mucoid culture of Streptococcus pioganes

Streptococcus citulorum Trevisan. (Aicrococco della durres binnea dei vitelini, Perroncito, 1889, Trevisan, I generie e le specie delle Batteriacce, 1889, 30.) From white durrhoea of calves.

Streptococcus rulgaris Locning (Münch, med Wochnschr, 67, 1910, 173 and 217, Streptococcus pyogenes rulgaris Thomson and Thomson, Ann Pickett Thomson Bes Lab, 5, 1927, 183.) Names applied to Streptococcus pyogenes.

Streptococcus versan Trovian (Atti d Accad Fisio Medico-Statistica in Milano, Ser. IV, 5, 1885, 149.) From lung evudate in pleuroppeumona of cattle.

Streptococcus sythi Trevisan (Torulacte de la bière maisile, Pasteur, Trevisan, I generi e le specie delle l'atteriacee, ISS), 31.) From spoiled beer.

Streptotaphylococcus parrulus Heurlin. (Heurlin, Bakt Unters d Keingchaltes im Genitalkanale der fiebernden Woehnerunca, Helsungsfors, 1910, 133) From genital canal Intermediate between Streptococcus anarrobius Krinig and Staphylococcus parrulus Veillon and Zuber.

Genus III. Leuconostoc Van Tieghem emend. Hucker and Pederson.\*

(Van Tieghem, Ann. Sei. Nat., 6, Sér. 7, 1878, 170; Betacoccus Orla-Jensen, The Lactic Acid Bacteria. Mem. Acad. Sei. Dancmark, Sec. d. Sci., 5, Sér. 8, 1919, 146; Hucker and Pederson, New York Agr. Exp. Sta. Teeli. Bul. 167, 1930, 66.) From Latin teueus, clear, colorless; M. L. Nostoc, a genus of blue-green algae.

Cells normally spherical Under certain conditions, such as in acid fruits and vegetables, the cells may lengthen and become pointed or even elongated into arod. Certain types grow with a characteristic slime formation in sucrose media. Grow on ordinary culture media, but growth is enhanced by the addition of yeast, tomato or other vegetable extracts. Generally, a limited amount of acid is produced, consisting of lactic and acetic acid; alcohol is also formed, and about one-fourth of the formented glucose is changed to CO<sub>2</sub>. Levo lactic acid is always produced, and sometimes dextro lactic acid also. Milk is rarely curdled. Fructose is reduced to mannitol. Habitat: Milk, plant luices.

The type species is Leuconostoc mesenteroides (Cicnkowski) Van Tieghem.

## Key to the species of genus Leuconostoc.

- I. Acid from sucrose.
  - A. Acid from pentoses.
    - 1. Leuconostoc mesenteroides.
  - B. No acid from pentoses.
- 2. Leuconostoc deztranicum.
- II. No acid from sucrose.
  - 3. Leuconostoc citrovorum.

 Leuconostoc mesenteroides (Cienkowski) Van Tieghem. (Ascococcus mesenteroides Cienkowski, Arb. d. Naturf Gesellsch, a. d. Univ. a Charkoff, 1878. Van Tieghem, Ann. Sci. Nat., 6, Sér. 7, 1878, 170, Leuconostoc indicum Liesenberg and Zopf, Beitr. z. Physiol u Morph mederer Organis., Heft 1, 1892, 19, Streptococcus mesenterioides Migula, Syst d. Bakt., 2, 1900, 25, Leuconostoc applutinans Barendrecht, Cent f. Bakt., II Abt , 7, 1901, 627; Leuconostoc aller Zettnow, Ztschr. f. Hyg., 57, 1907, 154, Leuconostoc opalanitza Zettnow, loc. cit; Betacoccus arabinosaceus Orla-Jensen, The Lactic Acid Bacteria, 1919, 152; Leuconostoc arabinosaceus Hol-Bact., 5, 1920. 223: land. Jour. Bacillus pleofructi Savage and Hunwicke,

Spec. Rept. Food Investigation Board, London, 1923, 134; Leuconostoe pleofruid Pederson, N. Y. Agr. Exp. Sta. Teb Bull. 150 and 151, 1929.) From Grest mesenterium, mesentery; cidus, form Gikel.

Probable synonym: Leuconosioe soyot Belenky, Bull. Sci., Res. Inst. for Leguminous Crops, Moscow (Russian), 5. 1934, 132.

Spheres: 0.9 to 1.2 microns in diameter, occurring in pairs and short or long chains. In sucrose solutions the chains are surrounded by a thick, gelatinous, colorless membrane consisting of dextran Gram-positive.

Glucose gelatin colonies Small, white to grayish-white, raised, nodular.

<sup>\*</sup> Revised by Prof. G. J. Hucker and Prof. Carl S. Pederson, New York State Evperiment Station, Geneva, New York, September, 1933, further revision, December, 1943.

Glucose gelatin stab: Growth along entire stab. No liquefaction. Sucrose broth: Abundant growth with

massive formation of slimy material.

Potato: No visible growth.

Indole not formed

Acid from glucose, fructose, galactose, mannose, xylose, arabinose, sucrose, and generally from lactose, rafinose, salicin and mannitol. Rarely acid from dextrin, starch, inulin, sorbitol, rhamnose or glycerol.

Nitrites not produced from nitrates.

Produces slime from sucrose Most pronounced in sucrose gelatin stab.

Aerobic, facultative.

Optimum temperature 21° to 25°C.

Distinctive characters. Active slime producer in sucrose solutions.

Source Slime in sugar factory
Habitat: Most active of the genus
Encountered in fermenting vegetable and
other plant materials Frequently isolated from slimy sugar solutions

2 Leuconostoc dextranteum (Beijerinck) Hucker and Pederson. (Lectococcus dextranteus Beijerinck, Folta
Microbiologica, Delft, 1912, 377; Betacoccus bors Joria-Jensen, The Lactic Acid
Bacteria, Copenhagen, 1919, 152 (Leuconstote bors Holland, Jour. Bact, 6,
1920, 223); Streptacoccus paracutrosorus
Hammer, Research Bul 63, Jowa Agr.
Exp Sta., 1920; Hucker and Pederson,
N. Y. Agr. Exp. Sta. Tech. Bull. 167,
1930, 67.) From Latin dezter, right;
M. L. dextranum, devtran, M. L. dextranucus, related to dextran.

Norr: The description of Streptococcus by, Freuderneich (Cent.f. Bakt., II Abt., 5, 1837, 47) renamed Streptococcus kefir by Migula (Syst. d. Bakt., 2, 1900, 44) is too indefinite to permit the determination of its exact relationship to the organisms in this genus. It is clear, however, that the Streptococcus kefir of these authors and that of Evans (Jour Agr. Res., 18, 1918, 235) were very similar to if not identical with Leuconostic extraordium. Streptococcus distendens Hammer (Iowa State Coll. Jour. Sci , 2, 1927, 5) may also be identical with Leuconostoc destrancum.

Spheres · 06 to 10 mieron in diameter, occurring in pairs and in short chains. Gram-positive.

Gelatin stab. Gray filiform growth in stab.

Agar colonies: Small, gray, circular, slightly raised, entire.

Glucose broth: Slight grayish sediment.

Litmus milk: Acid, coagulation. Frequently shows alight reduction of litmus in bottom of tube.

Potato · No visible growth.

Indole not formed.

Nitrites not produced from nitrates Produce slime from sucrose in rapidly

growing cultures.

Acid from glucose, fructose, galactose, maltose, sucrose, and generally from lactose and roannose. No acid from xylose, arabinose, glycerol, rhamnose, sorbttol, mannitol, starch, rarely raffinose, inulu or dextrin

Aerobie, facultative.

Optimum temperature of growth 21° to 25°C.

Distinctive characters: Produces moderate amount of slime in sucrose solutions.

Source · Dairy starters.

Habitat: Found both in plant materials and in milk products.

3. Leuconosioc citrovorum (Hammer) Hucker and Pederson. (Streptococcus citrovorus Hammer, Research Bull. No. 63, Iowa Agr. Evper. Sta., 1920, Hucker and Pederson, N. Y Agr. Exp. Sta. Tech. Bull. 167, 1930, 67) From Latin citrus, the citron tree, M. L., 1 emon or orange, bence citric acid, soro, devour.

Spheres: 0.6 to 10 micron in diameter, occuring in pairs and chains. Grampositive.

Gelatin atab: Filiform growth in stab. No liquefaction.

Agar colonies: Small, gray, entire, slightly raised.

Agar slant: Small, gray, discreto colonics.

Glucose broth: Slight gray sediment. Litmus milk: Slightly neid with partial reduction of litmus.

Potato, No visible growth

Indole not formed.

Nitrites not produced from nitrates. Grows poorly on ordinary media with-

out the addition of yeast extract or other growth accessory substance.

Acid from glucose, fructose, galactose and lactose. Generally does not form acid from mannose, sucrose, maltose, xylose, arabinose, rhamnose, raffinose, glycerol, dextrin, inulin, starch, salicin, mannitol or sorbitol.

Uses citrie acid in milk.

Aerobic, facultativo.

Optimum temperature 20° to 25°C.

Distinctive character: Non-slime producer.

Source. Dairy products

Habitat Found in milk and dairy products.

Appendix: This includes species that probably belong in this geaus. The descriptions are too meager to permit drawing any definite conclusion regarding their relationship to the three species recognized above

Migula. Bacterium laevolacticum (Bacillus acidi laerolactici Schardiager, Monatsh. f. Chemie, 11, 1890, 514; Migula, Syst d. Bakt., 2, 1900, 406; Bacterium acidi laevolactici Lehmann and Neumann, Bakt. Diag., 4 Aufl., 2, 1907, 178.) From well water.

Leuconostoc lagerheimii Ludwig. (Ludwig, Lehrb. d. niederen Kryptog. 1892. 29: Streptococcus lagerheimit Migula, Syst. d. Bakt., 2, 1900, 41.) From slimy sugar solutions.

Micrococcus gelatinogenus Brautigam. (Pharmaceutische Centralhalle, 1891, No. 30.) From the air. Forms gum in 60erose media.

Micrococcus gummosus Happ. (Inaug. Diss., Basel, published in Berlin, 1893, 31.) From slimy sugar solutions.

Muxococcus betae Gonnermann (Oesterr .- Ungar. Zischr. f. Zuckerind u Landw., 156, 1907, 883.) From sugar beet juice.

Streptococcus citrovorus-paracitrovorus Csiszar. (Milchwirtsch and Fortsch., 18, 1936, 68.) From cream and butter.

Streptococcus hornensis Bockhout. (Cent. f. Bakt., II Abt., 6, 1900, 162) From slimy, sweetened condensed milk. A strong dextran former. Related to Levennostoc mesenteroides.

Zoogloea termo Cohn. (Cohn, Nov. Act. Acad. Caes. Leop.-Carol. Nat. Cur., 14, 1854, 123.) The only species in the genus Zoogloca as originally proposed. From running water. Scheibler used this name for a zoogloea-forming organism from slimy sugar solutions in Neue Ztschr, I Rubenzucker- Ind., 1, 1878, 366 and probbably also in Ztschr. d. Vereins f. Rüben zucker- Ind , 1874, 330. The latter reference apparently is not available in America. See Buchanan. General Syst Bact, 1925, 530 for a history of the genus Zoogloea

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# Key to the species of genus Lactobacilius.

- I. Produce only traces of by-products other than lactic acid. Homofermentative. A. Optimum temperature 37° to 60°C or higher. Sub-genus Thermobacterium Orla-Jensen (The Lactic Acid Bacteria, 1919, 160).
  - Acid from lactose.
    - a. Optimum temperature 37° to 45°C.
      - b. Produce levo lactic acid.
        - 1. Lactobacillus caucasicus.
        - 2. Lactobacillus lactis.
      - bb. Produce inactive or dextro lactic acid.
        - e. Microaerophilie.
          - 3. Lactobacillus helreticus.
        - 4. Loctobacillus aeidophilus.
      - cc. Anacrobic in freshly isolated cultures. 5. Lactobacillus bifidus.
    - aa. Optimum temperature 45° to 62°C; usually no acid from maltose.
      - 6. Lactobacillus bulgaricus. 7. Lactobacillus thermophilus.
  - 2. No acid from lactose.
- S. Lactobacillus delbrucckii.
- B. Optimum temperature 28° to 32°C. Sub-genus Streptobocterium Orla-Jensen (loc. cit., 166).
  - 1. Acid from lactose.
    - a Produces dextro lactic acid. Often prefers lactose to sucrose and maltose.
      - 9. Loctobacillus cosei.
    - aa. Produces inactive lactic acid.

2 No acid from lactose.

- 10. Lactobacillus plantarum.
- 11. Lactobacillus leichmannii. II Produce considerable amounts of by-products other than lactic acid (carbon diovide, alcohol and acetic acid; mannitol from fructose). Heterofermentative. Sub-genus Betabacterium Orla-Jensen (loc. cit., 175).
  - A. Optimum temperature 28° to 32°C. Usually ferment arabinose.
    - 1. Does not ferment raffinose, and usually does not ferment sucrose or lactose. 12. Lactobacillus brevis.
      - Ferment raffinose, sucrose and lactose.
        - 13. Lactobacillus buchneri.
          - 14. Lactobacillus pastorianus.
  - B. Optimum temperature 35° to 40°C or higher. Usually does not ferment arabinose.
    - 15. Lactobacillus fermenti.

<sup>\*</sup> Also see discussion of Betabacterium caucasicum, p. 358.

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Minimum 18° to 22°C. Maximum 50°C. Source From milk and cheese.

Habitat: Undoubtedly widely distributed in milk or milk products.

3. Lactobaeillus helveticus (Orla-Jensen) Holland. (Bacillus e, von Freudenreich, Cent f. Bakt, H Aht., f, 1895, 173; also Landw Jahrb. d. Schweiz, 1895, 211, Bacillus case: e, v. Freudenreich and Thöni, Landw. Jahrb. d. Schweiz, 1904, 520, also Orla-Jensen, Cent. f. Bakt., II Abt., 13, 1904, 609; Cascobaeterium e, Orla-Jensen, Cent. f. Bakt., II Abt., 22, 1909, 337; Thermobaeterium helecticum Orla-Jensen, Maelkori-Bakteriologie, 1916, 33, also the Laetio Acid Bacteria, 1919, 164; Bacterium case: e, Holland, Jour. Bart, 6, 1920, 221, Holland, thât., 223 ) From Latin helecticus, Suiss.

Rods 07 to 09 by 20 to 60 mierons, occurring singly and in chains. Nonmotile. Cram-positive

Whey gelatin colonies Does not grow readily at temperatures required for incubation of gelatin

Lactose agar columes Small, grayish, viscid

Milk Acid, with congulation, may become slimy.

Nitrites not produced from nitrates Acid from glucose, fructose, galactose,

Acid from glucose, tructose, galactose, annose, maltose, lactose, and smaller amounts from destrin The lactic acid is mactive.

Temperature relations Optimum 40° to 42°C. Minimum 20° to 22°C Maximum 50°C.

Microaerophilie

Source: From sour nulk and cheese Habitat Widely distributed in dairy products.

4 Laetobaellus aeidophilus (Moro) Holand (Bazillus aeidophilus Moro, Wiener klin Wochnsehr, 13, 1900, 114; also Jahrb. f Kinderheilkunde, £2, 1900, 33; Holland, Jour Baet, £, 1920, 215, Plocamobacterium aeidophilum Lehmann and Neumann, Bakt Diag., 7 Aufl., 2, 1927, 510; Thermobacterium intestinale

Orla-Jensen, Orla-Jensen and Winther, Ceat. f. Bakt., II Abt., 98, 1936, 321.) From Latin acidus, sour; M. L. acidus, acid and Greek philus, loving.

Possible synonyms: Milehsäurebaullus, Boas and Oppler, Deutsche med Woehnsehr., 21, 1895, 73: Diagnostik und Therapie d. Magenkrankheiten, Il Tel, 1907, 265 (Lactobacellus boas-opplers Bergey et al., Manual, 1st cd., 1923, 243); Bacillus exilis Tissier, La flore intestinale des nourrissons, Paris, 1900, 102; Bacillus gastrophilus Lehmann and Neumann, Bakt. Ding., 4 Aufl., 2, 1907, 424 (Bucterium gastrophilum Lehmann and Neumann, Bakt. Diag., 5 Aufl., 2, 1912, 305); Bacillus acetogenus a Distaso, Cent i. Bakt., I Abt., Orig., 59, 1911, 49; Bacillus acctagenus & Distaso, 1bid., 51; Bacillus acetogenus proteiformis Distaso, ibid., 52; Bacillus acetogenus exilis Distaso, ibid , 53; Bacillus paraexilis Distaso, ibid , 56; Bacillus dimorphus Distaso, ibid, 55, Bacillus dimorphus var. longa Distaso, Cent. f. Bakt., I Abt., Orig., 62, 1912, 440; (Bacteroides dimorphus Bergey et al., Manual, 1st ed., 1923, 258); Streptobacillus longus Distaso, ibid., 439; Thermobacterium acidophilum Henneberg, Cent. Bakt., II Abt , 91, 1934, 102.

 Bakt., 11 Abt., 91, 1934, 102-Description of More supplemented by material from Kulp and Retiger, Jour. Bact., 9, 1924, 357; Curran, Rogers and Whittier, Jour. Bact., 26, 1933, 593; and Retiger, Levy, Weinstein and Wess, Lactobacillus acidophitus, Yale Univ. Press, New Haven, 1935.

Rods. 6 6 to 0 9 by 1 5 to 6 0 micross, occurring singly, in pairs and in short chains with rounded ends. Non-mothe Dimensions variable (Kulp and Retiget), (Curran, Rogers and Whittier). Grampositive; old cultures often Gram-negative (Moro).

Celatin: No growth at 20°C No lique

Wort-agar (Moro) or tomato agar (Kulp and Rettger) plates: Surface colonies, peripheries a capilliform mare of lossdelicate, twisted, fuzzy projections, certer appears as a thick, dark, felt-life mass. Deep colonies, small, irregularly shaped, with fine radiate or ramified projections.

Wort-agar slants · Growth scanty,

limited, dry, veil-like.

Wort-broth After 48 hours, fine, flocculent sediment. Other acid broths sediment whitish, slight turbidity

Milk · Slow growth with small inoculum. Coagulates from the bottom up

Potato · No growth.

Acid but no gas from glucose, suerose and lactose (Moro) Acid from glucose, fructose, gulactose, mannose, maltose, lactose and sucrose Some cultures ferment raffinose and trehalose and have slight action on devtrin Xylose, arabinose, rhamnose, glycerol, manniol sorbitol, dulctiol and insisted not fer mented (Kulp and Rettger) Inactive lactic seid and volatilo acids formed from sugars (Curran, Rogers and Whitter)

No visible growth in carbohydrate-free media (Retiger, Levy, Weinstein and

Weiss)

Optimum temperature 37°C No growth at 20° to 22°C (Moro) Maximum temperature 43° to 48°C (Curran, Rogers and Whittier).

Not pathogenic for laboratory animals

Microaerophilie

Distinctive characters Grows in acid media Unless frequent transfers are made, organism may become Gram-negative and rapidly develop characteristic degeneration forms (Moro) The so-called original strains of Becillus acidophilus from the Kráf collection, described and called Microbacterium lacticum by Orla-Jensen, do not have the characteristics given by Moro

Source: I'rom the feces of mik-led infants. Also from the feces of older persons on high milk or betose or dextrincontaining flets.

Habitat As for source

5 Lactobacillus bifidus (Tissier) Halland. (Bacillus bifidus communis and Bacillus bifidus Tissier, Recherches eur la flore intestinal des pourrissons, Paris, 1900, 85; Bacteroides bifdus Castellani and Chalmers, Man. Trop. Med, 3rd ed, 1919, 900, Holland, Jour Bact., £, 1920, 223, Nocardus hifda Vuillenini, Encyclopédie Mycolog, Paris, £, Champignons Parasites, 1931, 132; Actinomyces bifdus Kannizzi, in Pollacci, Tatt. Micopat. Umana, £, 1934, 13; Cohnisterptothriz bifdus Negroni and Fisher, Rev. Soc Argentina Biol., £0, 1944, 315.) From Lattn bifdus epili in two, cleft,

Possible synonyms: Cocrobocillus oriforms Tissier, Ann. Inst. Past., \$2, 100S, 189 (Bacterium oriforme Le Blaye and Gugenheim, Manual pratique de diagnostique Bactériologie, Paris, 1014; Bacteroides oriforms Levine and Soppeland, Iona Engineering Evp Sta Bul. 77, 1026, 35), Bacillus tentriosus Tissier, Ioc est. (Bacteroides tentriosus Eggerth, Jour. Bact., 30, 1035, 281), Diplobacillus acumnatus Distano, Ioc. est. (Bacteroides acumnatus Bergey et al., Manual, 1st ed., 1923, 200)

Description supplemented from Weiss and Rettger, Jour Bact . 28, 1934, 501.

Small, slender rods: Avenge length 40 microns, 05 to 0.7 by 2 to 8 microns (Wers and Rettger), occurring singly or in pairs and short claims, parallel to each other, very variable in appearance. Branched and club forms develop in some cultures. Non-motific Gram-positive but stams irregularly in old cultures.

Little or no grow than earlichydrate-free

agar (Weiss and Rettger)

Deep augur-agar colonies - After 3 days.

soud with slightly irregular edge, whitish.

Grow up to 3 cm from the surface forming
a ring Average diameter 3 mm. No

Sugar broth Good growth Turbid within 3 days Clears with floculent precipitate.

Milk Good growth with large inoculum No congulation (Tissier). May or may not congulate milk (Weiss and Rettger)

Acid from glucose, fructose, galactose,

sucrose, inulin and usually from destrin, starch, maltose, raffinose and trehalose. A few strains form acid from lactose and sahein. The acid co sists of inactive lactic acid and 18 to 25 per cent of volatile acid (Weiss and Rettger).

Optimum temperature 37°C. May show slight growth at 20°C Killed at 60°C in 15 minutes

Non-pathogenie for nuce or guinea pigs. Strict anaerobe (Ti-sier). Strict nagerobe in primary culture becoming microaerophilie (Weiss and Rettger).

Distinctive characters: Bifurcations and club-shaped forms (Tissier), particularly in infant feces and in primary culture (Weiss and Rettger).

Source From feces of nursing infants. Habitat Very common in the feces of infants. May constitute almost the entire intestinal flora of breast-fed infants. Also present in smaller numbers with bottle fed infants. Possibly more widely distributed than indicated in the intestines of warm blooded numble.

5a Lactobacillus parabifidus Weiss and Rettger (Inciterium bifidum Orla-Jessen, The Lactic Acid Bacteria, 1919, 192, Bactero des bifidus (Group 2) Eggerth, Jour Bact, 50, 1935, 295, Lactobacillus bifidus II or Lactobacilles parabifidus Weiss and Hottger, Jour. Bact., 55, 1938, 17; Jour Inf. Dis. 62, 1938, 115.)

This is the mo e anaerobic variety of the bifid organisms from feeces and seems to be more commo i in the intestine of adults. In contrast to Lactobacillus bifidus, it produces more volatile and as well as dextro lactic acid, and ferments arabinose, xylose and melezitose but not mannose.

6 Laclobacillus bulgaricus (Luerssen and Kuhn) Holland. (Bacillus A, Grigoroff, Revue Méd. Susse romande, 25, 1905; Bacillus bulgaricus Luerssen and Kuhn, Cent. f. Bakt., II Abt., 20, 1907, 211; Thermobacteri im bulgaricum Orla-Jensen, The Lactic Acid Bacteria, 1919, 164; Holland, Jour. Bact., 5, 1920, 225; Acidobacterium bulgaricum Schlirt, Cent. f. Bakt., I Abt., Orig., 97, 1925, 116; Plocamobacterium bulgaricum Lehmann and Keunaann, Bakt. Diag., 7 Aufl., 2, 1927, 511.) From Latin bulgaricus, of or related to Bulgaria.

Probable synonyms: Lactobacillus longus Beijerinek, Arch. néed. d. sc. exnet. et nat., Sér. 2, 7, 1901, 212 (not Lactobacillus longus Bergey et sl., Manual, 4th ed., 1931, 312); Bacterium casci filans Gorini, Rend. R. Ace, Lincel, 21, 1912, 472; Cent. f. Bakt., Il Abt., 37, 1913, 1.

Description of Lucrssen and Kühs supplemented by Grigoroff, loc. cit; Cobendy, Conpt. rend. Soc. Biol. Paris, 68, 1906, 361; Kuntze, Cent. f. Bakt, Il Abt., 21, 1908, 737; Bertrand and Duclacek, Ann. Inst. Past., 28, 1909, 402; White and Avery, Cent. f. Bakt., Il Abt, 28, 1910, 161; Rahe, Jour. Bact., 3, 1918, 420; Orla-Jensen, The Lactic Acid Bacteria, 1919, 164; Kulp and Rettger, Jour Bact., 9, 1921, 357; Sherman and Hodge, Jour. Dairy Sci., 19, 1936, 491.

Rods: Siender rods with rounded ends, often in chains. Non-motile. Gampositive, older cultures showing unstained portions (Lucrescen and Kuna).

Whey gelatin: No liquefaction (White and Avery).

Colonies: Flat, yellowish white, 2 lo 3 mm. Old cultures have dark centers Deep colonies globular (Luerssen and Kühn).

Whey agar colonies: Circular to irregu-

lar (White and Avery)
Milk. Coagulation at 37°C. No gas.

No decomposition of casein.

Potato Yellow-white colonies (Luersen and Kuhn). No growth (Grigoroff),
(Cohendy), (White and Avery).

Indole not formed (Grigoroff), (White and Avery).

Nitrites not produced from nitrates.
Results on acid production from sugars
vary. Glucose, lactose and galactose arapparently always fermented while xylose, arabnose, sorbose, rhamnose, ducitol, mannitol, deatrin, inulin and starch

are never fermented Larly norkers (Gigoroff) (Cohends) nated ferments tion of fructose, maltone and sucrees Later workers (Hertrand and Duchare k. (Orla Jensen), (Habe), (hulp and Rett ger), (Sherman and Hodge noted van able or negative results on sucrose and tuse and unbested fructuse

Forms high acidity in milk He lactic acid is inactive dingred! trand and Duchseck). (White and Average or levo (White and Avery . Orla Jersen with small numbities of volable and (White and Avery)

Aerobie or anaerobie Lucrescu and Kühn) Microserophilie Wlate Avery) Anaerolde in Inch indition (Sherman and Hodge)

Optimum temperature 45 to 714 Minimum 22°C (Lucrosen and Isula)

Distinctive characters. This significant at present is regarded as meluda at the high temperature organisms sudated from milk with difficulty. These let ment glucuse, galactuse and facture but usually do not ferment sucress malti-e of unheated fructose when freshly 140 Inted.

Source: Originally isolated from you

Habitat: Probably present in many milk products if held at high tempera titre

7. Lactobacillus thermophilus tyers and Johnson (Jour Bact , 9, 1921, 291 ) From Greek thermos, heat and philos, loving

Description of Ayers and Johnson supplemented by material from Charlton, Jour. Dairy Sci., 15, 1932, 393

Rods: 0.5 by 30 microns Stains arregularly. Non-motile (Charlton) Gram-positive

Gelatin stab · No liquefaction Agar plate Small colonies Agar slant · Slight, translucent growth (Charlton)

Broth, Turbid (Charlton) Litmus milk: Acid

Nitrites not produced from nitrates (Charlton)

Acid from glurose, lictise, sucrese, starch and trace from glycerol. No acid from silicia, manufol, influese or (Avers and Johnson) Iron fractose, galactice, gannese, maltose, raffinese and destrin. No acid from arthurers, as bee, glycerol, thampose, raliem, mulin or mannitel. Dextro lactic acid formed (Charlton)

The is the thermophilic lactobacillus obtained from pasteurised milk which causes our want colonies on agar idates.

Temperature relations Optimum tem persture 50° to 625°C Minimum 30°C Maximum G'C Thermal death point 71 (' for 3) minutes or \$2'C for 21 ninute«

Facultative amende. Gross best acrolocally

source From restourzed milk.

Habitat Known only Imm justcurited

b Lactobacillus deibrueckii (Leichmann) Beijerinck (Bacillus delbrückis Leichmann, Cent f Pakt, II Abt, 2, 1806, 281, Bacillus acudificans longiesimus Lafar, Cent 1 Bakt, Il Abt, 2, 1896, 195. Equillys (?) acidificans Micula. Syst d Bakt . 2, 1900, Sol , Begerinck, Arch neerl d ser exactes et nat., Haárlem, Str 2, 7, 1991, 212; Thermotacterium cereale Orla Jenun. The Lactic Acid Bacteria, 1919, 164, Bacillus acidificans longissimus Holland, Jour Bact, 5. 1929, 216, Lactobacillus acidificanslongissimus Holland, ibid , 216, Lactobacillus cereate Holland, ibid , 223; Lactobacterium delbrucki (sic) van Steenberge, Ann. Inst. Past., \$4, 1920, 820.) Named for Prof. M. Dellerück, German bacteriologist

Description of Leichmann supplemented by material from Henneberg. Cent f Bakt, H Abt, 11, 1903, 154 Rods 0.5 to 0.8 by 20 to 90 microns

(Henneberg), occurring singly and in short chains Non-motile. Gram-positire.

Gelatin colonies: Small, gray, circular, not liquefied.

Agar colonies: Small, flat, crenated.

Agar slant · Narrow, translucent, soft,
grayish streak

Broth · Slightly turbid.

Milk: Unchanged.

Mittles not produced from nitrates. Acid from maltose and sucrose (Leichmann) and glucose, fruelose, galactose and destrin. No acid from xylose, arabinose, rhamnose, lactose, mflinose, trehalose, inulin, starch, mannitol aramethyl-glucoside (Henneberg). Levo rotatory lactic acid is formed. Forms 16 per cent acid in mash.

This is the high temperature arganism of fermenting mashes. In fresh isolations it apparently has a higher optimum temperature than when held in pure culture.

Optimum temperature 45°C.

Mieronerophilic

Source From sour potato mash in a distillery

Habitat Fermenting vegetable and grain mushes

9 Latobaellius casel (Orla-Jonsen)
Holland (Bacillus a, v Freudenreich,
Ann d Microg , 1, 1890, 206, also Landw.
Jahrh d Schweiz, 1891, 20; Bacillus
case: a, von Freudenreich and Thöi,
Landw Jahrh d Schweiz, 1904, 526, also
Orla-Jonsen, Cent f Bakt, 11 Abt, 15,
1904, 699, Cascobacterum rulgare OrlaJensen, Maclkeri-Bakterologie, 1916, 38;
Streptobacterium case: a, Orla-Jensen, The
Lactic Acid Bacteria, 1919, 166; Bacterium case: a, Holland, Jour Bact., 5,
1920, 221, Holland, Jour Bact., 5,
1920, 221, Holland, Jour Bact., 5,
Rods Short or long chains of short or

long rods Non-motile. Gram-positive.
Milk. Acid with coagulation in 3 to 5
days or longer, may become slumy
Forms about 1 5 per cent lactic acid

Utilizes casein and therefore important in cheese ricening.

Acid from glucose, fructose, mannose, galactose, maltose, lactose, mannitol and

salicin. May or may not ferment sucrose. Mostly devtro lactic acid formed though a small amount of levo lactic acid may be formed. Only lactic acid produced with a trace of other by-products

This is the more common lactic said rod found in milk and mulk products. Orla-Jenson distinguishes it from Laciobacillus plantarum in that it produces dectro lactic acid and usually ferments lactose more readily than sucrose or maltose.

Temperature relations: Optimum 30°C.
Minimum 10°C. Maximum 37° to 40°C
and with some strains 45°C

Micronerophilic.

Source: From milk and cheese.

Habitat: Probably more widely dis tributed than indicated by isolations

10. Lectobactilus plautarum (Orla Jassen) Holland. (Streptobacterium planaturum Orla-Jensen, The Lastic Acid Bactoria, Copenhagen, 1919, 174; Holland, Jour. Bact., 5, 1929, 225) From Latin planta, sprout; M. L., a planta,

Probable synonyms: Bacillus pahuli acidi II Weiss, Inaug. Diss , Göttingen, 1898; Cent. f. Bakt., H Abt , 5, 1873, 509 (Lactobacillus pabuliacidi Berge) et al., Manual, 1st ed , 1923, 247); Bacillus cucumeris fermentati Henneberg, Ztschr. f. Spiritusindustice, 26, 1903, 22, Cent f. Bakt., II Abt., 11, 1903, 156 (Lactobacillus cucumeris Bergey et al. Manual, 1st ed., 1923, 250); Bacellus wortmannit Henneberg, Cent. f. Baht, II Abt., 11, 1903, 162 (Lactobacellus wortmannii Bergey et al., Manual, 3rd ed., 1930, 283); Bacillus Isters Henneberg, Ztschr. f. Spiritusindustrie, 20, 1903, 22; Cent. f. Bakt, H Abt, 11, 1903, 161 (Lactobacterium listers van Steenberge, Ann. Inst. Past., 34, 1929, 814; Lactobacellus lister: Bergey et al., Manual, 1st ed , 1923, 248); Bacellus maercki Henneberg, loc. cit.; Bacillus leichmanni II Henneberg, loc al, Bacillus bergerinckii Henneberg, Ztschr f. Spiritusindustrie, 26, 1903, 22; see

Cent f. Bakt, II Abt, 11, 1903, 159 (Lactobacillus beijerinchii Bergey et al., Manual, ist ed., 1923, 243), Lactobacillus pentosus Fred, Peterson and Anderson, Jour. Biol. Chem. 48, 1921, 410, Jour. Biol. Chem. 48, 1921, 410, Jour. Biol. Chem. 48, 1921, 410, Racterium busace asiaticae Techekan, Cent f. Bakt, II Abt. 78, 1929, 59 (Lactobacillus busacesiaticus Bergey et al., Manual, 3rd ed., 1930, 285), Racterium brassicae Wehmer, Cent f. Bakt, II Abt. 78, 1920, 285 (Lactobacillus busacesiaticus Bergey et al., Manual, 3rd ed., 1930, 285), Racterium brassicae Wehmer, Cent f. Bakt, II Abt., 10, 1903, 628 (Lactobacillus brassicae Lefevre, Abst. Bact. 6, 1922, 25)

Description from Orla-Jensen supplemented by material from Pederson, Jour

Bact., 31, 1936, 217

Rods: Ordnarily 0 7 to 10 by 30 to 80 microns, occurring singly or in short chains, with rounded ends Under favorable growth conditions these congainsms tend to be short rods Under adverse conditions they tend to be longer, for example, in tornato juice agar at 45°C (Poderson, N. Y. Agr Lxp Sta Tech Bull. 180, 1929) In fermenting vegetables, the organisms tend to become longer as the acidity becomes greater The organisms are usually longer to milk than in broths. Differences in morphology are well illustrated by Orla-Jensen. Normothe Gram-positive

Gelatin-yeast extract-glucose stab

Agar slant: Growth, if any, is very

Broth: Turbid, clearing after a few days. A few strains floceulate Litmus mulk; Acid, usually congulated

Nitrites not produced from mitrates The majority of strains form acid from glucose, fructose, mannose, galactose, arabinose, sucrose, maltose, lactose, rafilinose and salicin, and to a lesser extent, from sorbitol, mannitol, devtrin, glycerol and xylose Rhamnose, starch and intilin usually not fermented.

Lactic acid (usually inactive) with only small quantities of acctic acid and carbon dioxide is formed in the fermentation of hexose sugars Acetic and lactic acid are produced from the pentoses. Forms up to 1.2 per cent acid in broth.

This species is the inactive lactic acidproducing rod from fermenting materials but is closely related to Lactobacillus case. It ferments sucrose and maltose as readily as lactose

Salt tolcrance: Usually grows in salt up to 55 per cent.

Temperature relations · Optimum temperature 30°C. Minimum 10°C. Maximum 40°C. Thermal death point 65° to 75°C for 15 minutes

Alteronerophilic.

Sources from which isolated: Milk, cheese, butter, kefir, feese, fermenting potatoes, beets, corn, chard, bread dough, sauerknut, eucumber pickles, tomato pickles, cauliflower pickles and spolled tomato products.

Habitat Widely distributed in nature, particularly in fermenting plant and animal products

10a Lactobacillus plantarum var. rudensis Breed and Pederson (not Peterson), (Jour Bact . \$6, 1938, 667.) This chromogenic organism isolated from cheese is one of two species responsible for the development of rusty spots in cheese. It is impossible to determine whether the meampletely described species Bacillus rudensis Connell. Canadian Dept of Agric , Dairying Service, Ottawa. Report for 1897, 7 is identical with this variety of Lactobacillus plantarum or with Lactobacillus brevis var sudensis (see species No. 121) This chromogenesis is produced in starch media under anaerobic conditions.

 Lastobaellus Ielchmannil Bergey et al. (Bacilus Iechmanni I, Henneberg, Zischr. f. Spritusindustne, 26, 1900, 22; see Cent. Bakt., II Abt., II, 1903, 163; Bergey et al., Manud, 2nd ed., 1925, 189) Namel for Prof. G. Leichmann, a German Ineterologist

Probable synonym. Bacillus leichmanns III, Henneberg, loc cit Rods: 0.6 by 2 0 to 4 0 microns, occurring singly and in short chains. The cells show two or more deeply-staining granules Non-motile Gram-positive.

Gelatin stab · No liquefaction.

Agar colonies Small, clear with white centers.

Agar slant. Limited, grayish streak, better growth in stab

Broth. Turbid.

Nitrites not produced from nitrates. Acid from glucose, fructose, maltose, sucrose, trehalose, and slight mounts from galactose, mannitol and a-nethylgucoside. Lactose, rafinose, arabinose, rhamnose, devtrin and inulin not fermented. Forms 1 3 per cent lactic acid in mash

Optimum temperature 36°C. Maximum 40° to 46°C

Microaerophilic

The species is apparently similar to Lactobacillus delbrucchii but has a lower optimum temperature

Source From compressed yeast and from fermenting milk

Habitat Dairy and plant products

12 Lactobacillus brevis (Orla-Jensen) Bergey et al. (Bacillus 7, v. Freudenreich, Landw Jahrb. d. Schweiz, 1591, 22, Bacillus casci 7, v. Freudenreich and fhoni, Landw Jahrb d. Schweiz, 1904, 326, also Orla-Jensen, Cent f. Bakt, II Abt, 13, 1904, 604, Betabacterium breve Orla-Jensen, The Lactic Acid Bactoria, 1919, 175, Bergey et al., Manual, 4th cd., 1934, 312.) From Latin brevis, short.

Probable synonyms Bacillus brassicae fermentatae Henneberg, Zischr f Spiritusindustrie, 86, 1903; Cent f Bakt., II Abt., 11, 1903, 167 (Lactobacillus fermentatae Bergey et al., Manual, Ist ed., 1923, 252). Bacillus parus fermentati Henneberg, Zischr f Spiritusindustrie, 85, 1903, Cent. f Bakt., II Abt., 11, 1903, 168 (Lactobacillus parus Bergey et al., Manual, 1st ed., 1923, 251), Bacillus acidophil-aerogenes Torrey and Rahe, Jour Inf. Dis., 17, 1915, 437 (Lactobacillus Jour Inf. Dis., 17, 1915, 437 (Lactobacillus acidophil-aerogenes Torrey and Rahe, Jour Inf. Dis., 17, 1915, 437 (Lactobacillus acidophil-aerogenes Backet, 1948).

lus acidophil-acrogenes, Holland, Jour. Bact., 5, 1920, 216); Laclobacillus penicacticus Fred, Peterson and Davenport, Jour. Biol. Chem., 39, 1919, 357; Peterson and Fred, ibid., 42, 1920, 273; Laclobacillus penicacticus var. magnus Iwash, Jour. Agr. Chem. Soc. Japan, 16, 1910, 148, Lactobacillus lycopersici Mickle, Abst. Bact., 8, 1924, 403; Mickle, Abst. Bact., 8, 1924, 403; Mickle, Abst. Bact., 8, 1924, 403; Mickle, Bull. 110, 1925; Pederson, 1bid., Tech. Bull. 110, and 151, 1929; Bacterium soya Saito, Cent. f. Bakt., II Abt., 17, 1907, 20 (Lactobacillus soyae Bergey et al., Manual, 1st ed., 1923, 251).

Bacillus caucasicus von Freuderreich, Cent. f. Bakt., II Abt., 3, 1857, 185 and Belchaderrum caucastum Oth-Jensen, The Lactic Acid Bacteria, 1919. 173 were isolated from kefir grains and considered to be the organism Kemisolated in 1852. They are gas-producing lactobacilli but are less active toward sugars than Lactobacillus brevis.

Description supplemented by material from Pederson, Jour. of Bact, 35, 1933, 105.

Rods: 0.7 to 10 by 2.0 to 40 microns, with rounded ends, occurring singly and in short chains, and occasionally in log filaments which may show granulation

Non-motile. Gram-positive. Gelatin: No liquefaction.

Agar slant Growth, if any, faint Broth: Turbid, clearing after a few

Milk Acid produced but no clot except with some freshly isolated strains

Does not attack casein as a rule.

Is able to utilize calcium lactate as a source of carbon.

Acid from arabinose, xylose, glucose, fructose, galactose and maltose. Struss vary in fermentation of lactose, sucrose, mannose and raffinose Salicin, manuitol, glycerol, rhamnose, devtrin, inhand starch seldom fermented. Usually shows a particularly vigorous fermentation of arabinose.

Lactic acid usually inactive; acetic acid, ethyl alcohol and carbon dioxide

formed in fermentation of aldohexoses Mannitol produced from fructose. Acctic and lactic acid produced from the pentoses.

This species includes the large group of gas-producing lactic acid rods orthnarily characterized by a marked fermentation of pentoses, particularly arabinose. They usually also ferment fructose more readily than glucose

Temperature relations Optimum 30°C. Growth poor below 15° and above 37°C

Maximum 38°C.

Source: From milk, kefir, cheese, feces, fermenting sauerkraut, ensilage, manure, soils, sour dough, and spoiled tomato products.

Habitat: Widely distributed in nature, particularly in plant and animal products

12a. Lactobacillus breus var. rudensis Breed and Pederson (Lactobacillus rudensis Davis and Mattick, Proc Soc Agr. Bact., 1969, 3 (this organism is presumably the same as Bacillus rudensis Davis and Mattick, Jour. Dairy Res., 1, 1929, 50); Breed and Pederson (not Peterson), Jour Bact., 36, 1038, 667.) This chromogenic variety isolated from cheese ia a causative agent in the production of rusty spot in cheese. From a study of cultures, it is regarded as a chromogenic variety of Lactobacillus breus See 30s species No 10a.

13 Lactobaeillus buebner! (Ifenneberg) Bergey et al. (Bacillus buchner: Henneberg, Cent. f. Bakt, II Abt, II, 1003, 163, Bergey et al, Manual, 1st ed., 1923, 251.) Named for Prof E. Buchner, a German bactenologist

Probable synonyms: Bacillus wehmers Henneberg, Cent f Bakt, 11 Abt, 11, 1903, 165 (Lactobacillus wehmers Bergey et al, Manual, 1st ed, 1922, 249), Bacillus hayducki Henneberg, Cent f. Bakt, 11 Abt, 11, 1903, 163 (Lactobacillus hayduckit Bergey et al., Manual, 1st ed, 1923, 253); Bacierium mannitopocum Müller-Thurgau, Cent. f. Bakt, 11 Abt., 20, 1903, 396; ibid., 56, 1012, 129; ibid., 59, 1903, 396; ibid., 56, 1012, 129; ibid. 48, 1917 (Lactobacillus mannitopoeus Pederson, New York Agr Evp. Sta. Tech. Bell. 150 and 151, 1929, Lactobacillus mannitopoeus var fermentus Iwasaki, Jour Agr. Chem. Soc. Japan, 16, 1910, 146.

Description supplemented by material from Pederson, Jour Bact., 35, 1938, 107. Rods 0 35 by 0 7 to 4 0 microns, occurring singly, in pairs and chains or in filaments 25 microns or longer. Non-motile. Gram-rositive.

Agar colonies · White to yellowish, adberent

Agar slant Growth, if any, faint. Broth: Turbid, clearing after a few days.

Latmus milk: Usually unchanged but may be slightly acid with no reduction. Natrites not produced from nitrates.

Acid usually from arabinose, xylose, glucose, fructose, galactose, mannose, sucrose, lactose, maltose and raffinose. Mannitol, sorbitol, glycerol, rhamnose, salicin, inulin, dextrin and starch fer-

mented by a few strains
Lactic acid usually inactive. Acetic
acid, ethyl alcohol and carbon dioxide
formed in the fermentation of aldohoxoses Manntol produced from retose. Acetic and lactic acid from pentoses.

Strams of this species might be considered intermediates between Lacto-bacillus breits and Lactobacillus fermenti.

Forms I 3 per cent lactic acid in mash

and 27 per cent alcohol.

Optimum temperature 32° to 37°C.

Minimum 10° to 15°C. Maximum 44° to 48°C.

Source: From sour mash, pressed yeast, molasses, wine, catsup and sauerkraut. Habitat Widely distributed in fermenting substances

14. Lactobacillus pastorianus (Van Laer) Bergey et al. (Saccharobacillus pastorianus Van Laer, Cont. l'Ilistoire des Ferments des Hydrates de Carbone, Acad. Roy. de Belge, 1892; Bactilus pastorianus Macé, Traité Pratique de Bact, 4th ed., 1901, 957; Lactobacterium pastorianum van Steenberge, Ann. Inst. Past., 54, 1920, 816; Bergey et al., Manual, 1st ed., 1923, 246.) Named for Pasteur, Freuch chemist; from Latin pastor, a herdsman.

Probable synonyms: Saccharobacillus pastorianus var. berolinensis Henneberg. Cent. f. Bakt, II Abt., 8, 1902, 186 (Lactobacillus berolinensis Bergey et al., Manual, 1st ed , 1923, 246); Bacillus lindneri Henneberg, Wochnschr, f. Brauerei, 18, 1901, Nn. 30; Cent. f Bakt., II Abt., 8, 1902, 184 (Lactobacillus lindneri Bergey et al., Manual, 1st ed , 1923, 245); Bacillus fasciformis Schönfeld and Rommel, Wochnschr. f. Brauerei, 19, 1902, No. 40; abst. in Cent. f. Bakt., II Abt., 9, 1902, 807 (Saccharobacillus berolinensis fasciformis Henneberg, Handb. der Gärungsbakteriologie, 2, 1926, 123; Bacillus belorinensis (sic, evidently intended for Bacillus berolinensis) Otani, Cent. f. Bakt., II Abt , 101, 1939, 149).

Description supplemented by material fram Henneberg, Cent f. Bakt., II Abt., 8, 1902, 184; Shimwell, Jour Inst. Brewing, 41, 1935, 481, and Pederson, Jour Bact. 55, 1938, 107.

Rods. 0 5 to 1 0 by 7.0 to 35.0 microns, occurring singly and in chains Nnn-motile. Gram-positive.

Gelatin colonies. No growth

Beer wort gelatin stab. Beaded to arborescent growth.

Beer wort agar colonies. Small, gray, raised, filamentous.

Agar slant Little or no growth; better in stab.

Broth: Good growth in yeast extract. Turbid

Litmus milk Acid.

Nitrites not produced from nitrates.

Acid from arabinose, glucose, fruetose, galactose, maltose, sucrose, devtrin, raffinose, trhalose and mannitol and slightly from lactose and starch. No acid from xylose, rhamnose or inulin. Forms 15 per cent acid in mash. Alsn forms CO<sub>2</sub> and alcohol, lactic, formic and acetic acid.

The species includes the ordinarily long rod types from spoiled beers. Apparently the same variations in regard to sugar fermentation may be found as are noted for similar species.

Optimum temperature 29° to 33°C. Minimum 11°C. Maximum 37°C.

Microaerophilie.

Source: From sour beer and from distillery yeast.

Habitat: Probably more widely distributed than indicated by isolations.

 Lactobaelllus fermendl Beljerinck, (Beljerinck, Arch., néerl. d., sc., euctes et nat., 56r. § 7, 1901, 212; Smit, Zusch.
 Garungsphysiol., 5, 1916, 273; Lactobacterium fermentum van Steenberg, Ann. Inst. Past., 54, 1929, 516.) From Latin fermentum, ferment, yeast.

Probable synonyms: Bacillus 8, von Freudenreich, Cent. f. Bakt, II Abt, 1, 1895, 173; also Landw. Jahrb d. Schweiz, 1895, 211; Bacillus casei 8, von Freudenreich and Thöni, Landw. Jahrb d. Schweiz, 1904, 526; also Orla-Jensen, Cent. f. Bakt., II Abt., 13, 1904, 609; Betabacterium longum Orla Jensen, The Lactic Acid Bacteria, 1919, 174 (Lactobacillus longus Bergey et al., Manual, 4th ed., 1934, 312); Bacterium gayonn Miller-Thurgau and Osterwalder, Cent i Bakt., II Abt., 48, 1917, 1 (Lactobacellus gayonii Pederson, New York Agr. Exp Sta. Tech. Bull. 150 and 151, 1929); Bacterium intermedium Muller-Thurgan and Osterwalder, Cent. f. Bakt , 11 Abt , 48, 1917, 1 (Lactobacillus intermedium Bergey et al., Manual, 3rd ed., 1930, 295); Bacillus aderholdi Henneberg, Cent. i. Bakt , II Abt., 11, 1903, 166.

Description supplemented by material from Pederson, Jour. Bact., \$5, 1935, 196.

Rods: Variable, usually short (Berlerinck), 0.5 to 1.0 by 3.0 to 150 micross (Smit), sometimes in pairs or chaus. Nan-motile. Gram-positive (Smit).

Yeast extract-glucose-gelatin: Filiform, no liquefaction (Pederson). Agar colonies: Flat, circular, small, translucent like droplets of water. Agar slant: Growth, if any, scant. Broth. Turbid, clearing after a few days

Milk: Unchanged or slightly acid. Nitrites not produced from nitrates

Reduction of litmus, methylene blue, indigo carmine, sodium thiosulfate Na<sub>2</sub>SO<sub>1</sub> is reduced to H<sub>2</sub>S (Smit)

Acid usually from glucese, fructose, maltose, sucrose and lactose (Beyerinck) and mannose, galactose, and raffinose, some strains ferment xylose, usually does not ferment arabinose, rhamnose, sorbitol, mannitol, inulin, devtrin, starch or salicin (Pederson).

Lactic seid, usually mactive; acette acid, ethyl alcohol and carbon dovude are formed in the fermentation of aldehevoses (Smit), (Pederson). Mannitol is formed in the fermentation of fructose (Beigerinek), (Smit). Acetic acid and lactic acid are produced from pentoyes if they are fermented (Pederson).

These are the bigher temperature gasproducing rods. They usually do not ferment the pontoses but when they do, the fermentation is seldom as active as that produced by strains of Lactobacillus bretis.

Temperature relations Optimum 41° to 42°C. Minimum 15° to 18°C. Maximum 48° to 50°C.

Microaerophilic.

Source: From yeast, milk products, fermenting dough, potatoes or vegetables, tomato products and wine.

Habitat Widely distributed in nature, particularly in fermenting plant or animal products.

Appendix I: The following species probably should be included in the genus Laciobacillus. Many are duplicates of the species described in full, but the majority are so poorly characterized that they cannot be properly identified. Acidobacterium aerogenes Schlirf. Stabebon Ka, Heim, Cent f. Bakt., I Abt., Orig, 33, 1924, 252, Schlirf, Cent. f. Bakt., I Abt., Orig., 57, 1925, 114; Plocamobacterium aerogenes Lehmann, in Lehmann and Neumann, Bakt. Disg., 7 Aufl , 2, 1927, 500 ) Possibly Lactobacillus breus Bergey et al. Produces acid and gas from glucose. From dental caries, mouth cavity and intestine.

Acidobacterium lactis Heim. (Heim, quedobacterium lactis Heim.) (Heim, dath, 17 Abt., Orig., 87, 1925, 113.) Schlirf says that this species is probably identical with Bacillus necrodenialis Goodby. Regarded by Lebmann (in Lehmann and Neumann, Bakt. Ding., 7 Aufl., 8, 1927, 507-508) as identical with Bacillus octophilus Moro; or it may be identical with Steeplobacterium casis Orla-Jensen From dental caries, deposit on tongue and in intestine

Acidobacterium moros Soblirf. (Stabchen Ke, Heim, Cent. f. Bakt, I Abt., Orig, 93, 1921, 252, Schlurf, Cent. f. Bakt, I Abt., Orig., 97, 1923, 114 Plocomboacterium moro Lehmann, in Lehmann and Neumann, Bakt. Digg, 7 Aufl, 2, 1927, 598) From the intestine. Similar to Acidobacterium lactur. Kuchinka (Cent. f. Bakt, I Abt., Orig, 144, 1939, 370) reports this organism as occurring in two cases of meanurills.

Bacillus bifidus aerobius Heurlin. (Bakt Unters d Keimgehaltes im Genitalkanale d fiebernden Wöchnerinnen Helsunfors, 1910, 93) From the genital canal Resembles Bacillus bifidus communis Tissier

Bacullus bifidus capitatus Heurlin. (Bakt Unters. d. Keimgehaltes im Genitalkanale d. fiebernden Wöchnerinnen Helsingfors, 1910, 175.) From the genital canal.

Bacıllus carpathiens Kindraizuk. (Oesterr. Molkerei Zeit., 29, 1912, 257.)

Arranged by Prof. C. S. Pederson, New York State Experiment Station, Geneva, New York, March, 1945

From the sour milk of the Carpathian region. Presumably Lactobacillus bulgaricus.

Bacillus circularis minor Heurlin.
(Bakt Unters d. Keimgehaltes im
Genitalkanale d fiebernden Wochnerinnen Helsingfors, 1910, 170) From the
genital canal. Anaerobic.

Bacillus neerodentalis Goadby. (Goadby, Microorganisms in dental earries, Dental Cosmos, 42, 1990, 213) From dental earies

Bacillus orenburgii Horowitz-Wlassowa. (Cent f Bakt, II Abt., 64, 1925, 338.) From kumys (Caucasus). Presumably Lactobacillus bulgaricus.

Bacillus orientale Batchinsky (Batchinsky, Arch d Gesellsch, d., Naturf St Petersburg, 42, 1911; quoted from Horowitz-Wlassowa, Cent f Bake., II Abt, 64, 1925, 330.) From kumys in Ufa (U S S R) Presumably Lactobacillus bulgaricus.

Bacillus sardous Grixoni. (Annali di Med Navale, 118, 1905, 223 and Cent. f. Bakt, II Abt, 15, 1905, 951, Bacterium sardum miciurati: Biauco, II Cesalpino, 8, 1912, 33) Prom gioddu (Sardinia). Presumably Lactobacillus bulgaricus bulgaricus.

Bacillus vaginae Kruse (Scheidenbacillen, Doederlein, Das Scheidensekret und seine Bedeutung für das Puerperalfieber, Leipzig, 1892, 32; Kruse, in Flugge, Die Mikroorganismen, 3 Aufl, 2, 1896, 358; Bacillus vaginalis longus Heurlin, Bakt Unters d Keimgehaltes im Genitalkanale d fiebernden Wochnerinnen. Helsingsfors, 1910, 170; Bacıllus vagınalıs Jotten, Arch f Hyg, 91, 1922, 149. Stabchen Ke, Heim, Cent f Bakt, I Abt , Orig , 93, 1921, 252; Acidobacterium doederleinii Heim, quoted from Schlirf, Cent f Bakt, J Abt, Orig, 97, 1925, 104; Plocamobacterium vaginac Lehmann, in Lehmann and Neumann, Bakt Diag, 7 Aufl , 2, 1927, 510, Lactobaciltus doederlein Gillespie and Rettger, Jour. Bact., 1938, 623 ) Kruse (Allgemeine Mikrobiol., 1910, 287) considers this species a "langen Milchsaurebacillus" all of which he would group under the name

Bacillus lacticus (not Bacillus lacticus Kruse, in Flugge, Die Mikroorganismea, 3 Aufl., 2, 1896, 356 as this is Streptooccus lactis Löhnis). Jotten (loc. cil.) and Thomas (Jour. Inf. Dis., 43, 1932, 218) consider this species identical with Lactobacillus acidophilus (Moro) Holland. From the secretion of the normal vaguma. See Bacillus crassus Lipschüt.

Bacterium gracile Muller-Thurgu (Cent. f. Bakt., II Abt., 29, 1993, 396, Muller-Thurguu and Osterwalder, ibid, 36, 1912, 157; ibid, 48, 1917, 1; Latol bacullus gracile Bergey et al, Manul, 3rd ed., 1939, 297.) This organism which was isolated from wine is probably not a lactobacillus. It may belong to the genus Leuconastoc (subculture evamined in 1936. C. S. Pederson).

Bacterium granulosum Lehmann and Neumann. (Kötnehenbacillus, Luerssen and Kuhn, Cent. f. Bakt., II Abt. 29, 1907, 241; Lehmann and Neumann, Bakt. Ding, 5 Aufl., 2, 1912, 306.) From yoghurt (Bulgaria). Presumably Ladabacillus bulgariars.

Bacterium lactis commune Hohennadel. (Arch. f. Hyg., 85, 1916, 237.) From feces Similar to Lactobacillus acidophilus (Moro) Holland

acadopatus (Moro) Hollada Bacterium marun Weigmann, Grabet and Huss (Milchaurebakterium aus Marun, Düggeli, Cent. f. Bakt, II Abt, 15, 1905, 505; Weigmann et al., Cent i. Bakt., II Abt., 19, 1907, 78) From maxun (Armenia). Presumably Lader bactilus butlgaricus.

Bacterium rermiforme Ward (Phil.
Tran. Roy Soc. London, 183, 1892, 19;
Bacillus rermiforms Migula, Syst. de
Bakt., 2, 1900, 652; Betabacterium traniforme Mayer, Inaug. Diss, Univ.
Uttrecht, 1933. Originally isolated from
the ginger beer plant fermentation
This is presumably a slime forming
lactobacillus.

Bacteroides aerofaciens Eggerth and Bacteroides biformis Eggerth (Jour Bact, 50, 1935, 232-283.) From fece Possibly hactobacilli but their relationships are not definitely known.

Lactobacillus betadelbrueckii Kitahara (Bull Agr. Chem Soc. Japan, Tokyo, 16, 1910, 123.) From cereal mash

Lactobacillus cancus Kitahara (lor cit.). From cereal mash

Lactobacillus ciliatus Kitabara (bec cit.) From cereal much Lactabacellus enzumothermophilus

Buck, (Amer. Jour Pub Health 32, 1912, 1230 ) A thermophilic (growth at 52° and 62°C) presumable spore forming bacillus isolated from posteurized milk Lactobacillus fructororans Chariton,

Nelson and Werkman than State Coll. Jour. Sci., 9, 1934, 1 ) I rom said dressing. Similar to Lactobacillus bres is Lactobarillus hiloardii Diriglis aml

Cruese (Food Research, 1, 1936, 113) This organism was real sted from wine but is not completely described and so can not be commared with previously de ertilled species

Lactobacillus hyochi Otam Lactobacil lus hyocht var. 1, Otani. Latobaciffus hyochi var. 2. Otsus, Lactobacillus fila mentorus Otanii Lactobacellus alcohol philus Otani, and Lactobacillus sapra genes Otani. (Jour Parulty of Agric . Hakkaida Inin Unis . 39, 1936, 21 These organisms were real sted from sike With the possible exception of the last type, they are probably identical with Lactobacillus plantarum ur chosels related PINCICA.

Lactobacillus odontolyticus Radrigues (Bucillus acutaphilus odontolyticus ! and II, McIntosh Junes and Lazarus-Barlow, Brit Jour Lap Med and Path . 3, 1922, 141; Bacillus aredophilus estanto lyticus, abid , 115, Lactobacillus odinto lyticus and Lactobacillus adentalyticus Types 1, 11 and 111, Redriguez, Militars Dent. Jour., 5, 1021, 200, Bacilles wies tolkheus Melntoch, Junes and Lararus Parlon, But, Jour Tap Med and Path 8, 1921, 178; Bacillus aculophilus at in tolking Rosebury, Lanton and Buch birder, Jur Biet . 18, 1979, 287, Lact. Cacillas retente lutions I and II. Toples and Wilson, Princ Buct, and Inmora 2rd ed , 1936, 555.) Trom dental carree

Type I resembles and is possibly identical with Bacillus acidophilus Moro and Doederlem's Incillus (Bacillus vamnae Aruse! See Rosebury, Bact, Rev., 8 1914, 189 and Arch of Path., 38, 1914. 413 Type 11 shows considerable pleomerphism, short excent forms appearing in the more alkaline media (McIntosh. James and Lazarus-Birlow, Brit Jour, I vp. Med. and Path., 8, 1921, 183). Types 1, II and III of Rodriguez (loc. ed i do not correspond with Types I and II of Melatosh et al or with the groupmes of Howe and Hatch (Jour Med Res. 36 1917, 151)

Lactobacillus panis acidi Nikoliev (Wass Forschungsmet Bäkerei indust., 1 S S R , 5, 1933, 3-11.) Four malations from bread dough designated by the tireck letters, a, B, 21 and 21

Loctobacillus sake Katagiri, Kitahara, Inkama and Sugre (Hull Chem Soc Japan, 10, 1931, 153 ) From much used in the manufacture of sake Smulge to Lactobacillus plantarum.

Lactobacillus xulosus Kitaliara (Bull. Aer Chem Soc Jupon, Tokyo, 10, 1910. 121 i l'mm cere il mash

Luciobacterium ecreriniae van Steenberge (Ann Inst Past , \$4, 1926, 406.) I rom beer

Lactobact-enum conglomeratum van Steenberge the cit, 812). From beerunt

Lactobacterium filmim van Steenberge dec cit. 812) From beer wort

Lact bacterium Poccogenum von Steen here the cit, \$12) I'min beer wort Lactificaterium grace van Steenberge

the cit, 811) I'm beer nort Lact Sactorium multiculationm van

Steenlaste flor ret. 511) From Leet. Buft

Lactid-seterium militarlitazenum van Steenberge (for cit, 412) I'mm beer. Brett.

Lact I acterium of sparety cane van Steenberge, the est, 411; I pur beer. MITTS.

Lactobacterium parcifermentans van Steenberge (loc. cit., 812) From beerwort.

Lactobacterium terricola van Steenberge (loc. cit., 806). From garden soil.

Lactobacterium viscoaenum van Steenberge (loc cit, 814). From beer-wort. Streptobacillus lebenis Rist Khoury. (Rist and Khoury, Ann. Inst. Past., 16, 1902, 70; Bacillus Icheni Kuntze, Cent. f. Bakt , II Abt., 21, 1908, 744, Streptobacillus lebensis a and B Lohnis, Cent f. Bakt., II Abt , 22, 1909, 553; Streptobacillus lebenis riscosus and Streptobacillus Ichenis nonviscosus Severin, Cent f. Bakt, II Abt., 24, 1909, 488; Bacterium lebenis Lehmann and Neumann, Bakt. Diag., 5 Aufl., 2, 1912, 308) From leben (Egypt and Near East) Presumably Lactobacillus bulgaricus

Streptothrix dadhi Chatterjee (Cent. f Bakt, I Abt, Orig, 53, 1910, 111.) From sour milk (dadhi) of India Presumably Lactobacillus bulgaricus.

Thermobacterium jugurt Orla-Jensen (Yoghurt bakterium, Kuntze, Cent. f Bakt, H Abt., 21, 1908, 737, Orla-Jensen, The Lactic Acid Bacteria, 1919, 164; Lactobacillus jugurt Holland, Jour. Bact., 6, 1920, 225.) From jughurt (Bulgaria). Presumably Lactobacillus bulgaricus.

Thermobacterium mathiacolle Cecilia. (Le Lait, 20, 1940, 385-390) From sweetened condensed milk. Possibly a spore-former

Appendix II.\* The genus Leptotrichia Trevisan, 1879 is no longer recognized as a valid genus While the confusion with Leptothriz Kutzing, 1843 was corrected by Trevisan's work, the identity of the type species, Leptotrichia becalis, is uncertain Few of the species that have been placed in Leptothriz and Leptotrichia are well enough described to be

recognized with certainty

All descriptions of Leptotrichia buccalis published earlier than 1886 are based on microscopic observations only. This is also true of the three species of Leptothrix recognized by Miller (Die Mikmorganismen der Mundhohle, Leipzig, 1889, 69-80). The species that he distinguished in this way are recognized in the seven editions of Lehmann and Neumanu's Bakteriologische Diagnostik published from 1896 to 1927. Chester (Manual Determ, Bact., 1901, 371) also follows Miller's ideas in regard to the nature of the species of Leptothriz These authors felt that the identity of the true Leptotrichia buccalis was doubt. ful.

On the other hand, Vignal (Arch. de Physiol. norm. ct path., 8, 1886, 337) isolated what he thought to be this organism, and it is his description that is used with minor changes by Eisenberg (Bakt Ding., 3 Aufl., 1891, 134), Miguli (Syst. d. Bakt., 2, 1900, 445) and in all editions of Bergey's Manual (1923-1939) up to the present edition. A study of Vignal's work shows, however, that the filamentous organism that he isolated and grew readily in broth, agar and gelatin cultures was in all probability one of the common spore formers. It grew but rarely on the plates inoculated with material from the mouth. As is clearly shown in his drawing and descriptions, it liquefied gelatin rather quickly with the formation of the characteristic writkled pellicle of a spore former Soon after, Arustamow (Wratsch, 1889, Nos. 3 and 4; abstract in Cent f. Bukt, 6, 1889, 349) isolated a similar serobic, filamentous organism that grew readily at 37°C on agar and gelatin, but he also noted large numbers of very tiny colonies of a microaerophilic bacterium which may have been the lactobacilli or lactobacilli-like organisms ol later authors. Even recent excellent reviews of the

Completely rearranged by Prof. Robert S Breed and Prof. Carl S. Pederson, New York State Experiment Station, Geneva, New York, March, 1945.

early Electron (Barbinson) asymmetric Bert, 1821, 182-182; T. J. v. Hartman and Rev. North Tables are Aded I Obs. I. Finth-Nett. Elmo. No. 5, 1823, Stpplerorders of the a minorial studies of the part ellipsy years. Rosebury, Revt. Rev., 4, 1845. — 5,01 to cher arry all of the word my a track has streen.

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The type speries is Leriarchia baccalis (Robin Trivial

Leptotrichia lucrani fine i Trefain. Coppoling Incre : Louis Extrag naturalle des vegrant monte les Taria, 1803, 254, Trevisus Lone Branco Lombardo da Sorrare e Le 107 Ser II. 4, 1879, 147 Lep, ut to III Thesmussen, Om Drytsman e Mart spansoner fra Spyr of suppr Mannesur IRS: Barnusteria curicus Ir Inn. and Trevisia in Sulman in 1761 Turnitum. s 150 53 Baur un turren Mirale. Syst d East & 130 -40 ave Lordethat ture I Court "Loren Direm. Bilt, 14 . J. o : Jan' to home lis Cherts 7 - In na Faultur (www.in-Treusas I gener e l'erorie sulle Patsermore loss if Sources currelle Enderseit Strumster Ges Narun Frenche Be- 1 to til Bereiler pares of Housest And Bart. C. 302", 21° F-22 '34 22 - 2

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Leptothrix falciformis Beust. (Dental Cosmos, 50, 1908, 594; Jour. Dent. Rcs., 16, 1937, 379) From the mouth.

Leptothriz filiforms Castellani and Chalmers. (Bacillus (Leptothriz?) pyogenes filiforms Flexner, Jour. Exp. Med., 1, 1896, 211; Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 1063.) From the genital tract and thoracic cavities of a rabbit with an acute pleuritis, pericarditis, pneumonia and acute endometraits. Gram-negative. Not regarded as identical with Bacillus pitiforms Tyzer (Jaur. Med. Res., 87, 1917, 307) which is a spore-former.

Leptothrix gigantea Miller (Miller, Ber d. deutsch bot. Gesell, 1, 1883, 221; Leptotrichia gigantea Trevisan, I generie le specie delle Batteriacce, 1889, 10; Rasmussenia gigantea De Toniand Trevisan, in Saccardo, Syllege Fungorum, 8, 1889, 030.) From pyorthæa in dogs, swine and sheep. This name was applied to a mixture of species.

Leptothrix haemoglobinophila sporulens Mackenzie (In System of Bact, Med. Res. Council, London, 8, 1931, 99) From cerebro-spinal fluid. A Gram-negative

spore-former.

Leptothriz innominata Miller. (Die Microrganismen der Mundholle, 1889, 51, Leupzig; Pseudoleptothriz innominata Prévot, Ann Inst Past, 60, 1938, 301) Prévot (loc. cit) regards thus species as type for his new genus Pseudoleptothriz Proposed to include all filamentous forms from the mouth that resemble Leptothriz buccalis (Nobin

Leptothrix insectorum Robin (Histoire naturelle der végétaux parasites, Paris, 1853, 354) From the rectums of insects.

Leptothrix maxima buccalis Miller. (Aliller, Deutsche med Wehnschr, 14, 1888, 612; Leptotrichia maxima Trevisan, I generi ele specie delle Batteriacee, 1889, 10; Rasmussenia maxima De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1880, 930; Leptothrix buccalis Chester, Man. Determ Bact., 1901, 371; Bacillus

maximus Goadby, Mycology of the Mouth, 1903, 191.) From the mouth

Leptothvir parastitca Kutzing. (Kūtzing. ting. Bot. Zeitg., 1847, 220; quoted from Winter, in Die Pilze, Rabenborste Kryptogamen Flora, 2 Aufl., 1, 189, 57; Bacterium parastiteum Billet, Boll Sci. de la France et de la Belgique, Para, 21, 1800, 190.) From a brownish deposit on alexae.

Leptatrix preputialis Vicentiai. (Atti Accad. Med. Chir. di Napoli, 43. 1820-91, quoted from Vicentini, Bateris of the Sputa. Trans. by Stuter and Saleghi, London, 1897, 89.) From the urethra.

Leptothrix pyogenes cuniculi Musetella. (Aluscatella, 1899, quoted Iron Nannizzi, in Pollacoi, Tratt. Micopat Umana, 4, 1934, 57; Leptotrichia cuniculi (sic) Nannizzi, ibid., 57.) From spontaneous suppuration in a rabbit.

Leptothrix racemosa Vicentini.
(Vicentini, Atti d. r. Accad. Med. Chir
di Napoli, 46, 1892, 459; Leptotrichis
racemosa Nannizzi, in Pollacci, Tratt.
Micopat. Umans, 4, 1834, 55.) From
the mouth. Conidia-like bodies an
described. See Vicentini, Bact. of the
Sputa, Eng. Trans. by Stuter and Safeghi,
London, 1897 and Williams, Denki
Cosmos, 41, 1899, 330.

Leptothriz racemasa tincenti (sie)
Mackenzie. (Leptothrix, Matthes,
Pract, 74, 1905, 197; Mackenzie.
System of Bact, Med. Res. Cound,
London, 8, 1931, 94.) From localized
empyema. Appears to be the same
as Vicentini's organism.

Leptothriz vaginalis Donné (Donné, quoted from Nannizzi, in Pollacci, Tati Micopat. Umana, 4, 1934, 56; Leptotrichie raginalis Nannizzi, ibid., 56.) Saprophyto from the vagina.

Leptothriz vaginalis von Hem (Ueber Scheidenmykosen, Samml. Lin Vortr. n. F., 1895, No. 137.) From a case of vaginal mycosis.

Leptothriz variabilis Rasmussen (Rasmussen, Om Dryckning of Mero organismer fra Spyt of sunde Mannesker, 1883; Leplothriz II, Zopf, Dio Spaltpillo, 3 Aufl., 1885; 107; Leplothreha caribillo, Trevisan, I generi e le specie delle Batteriacae, 1889, 10; Rasmussenia carabitis De Toni and Trevisan, in Saccardo, Sylloge Fangorum, 8, 1889, 931) From saliva.

Ramussenia oneips De Toni and Trevisan. (Leptothrix I, Rasmussen, Om Dryckning of Microorgamenter fra Spyt of sunde Mannesker, 1883, Batteriopsis ramussen Trevisan, Auti della Accad. Fisio-Med -Stat in Milano, Ser IV, 5, 1883, 103, Bactline rasmussen Trevisan, I, generic le specie delle Batteriacee, 1889, 15; De Toni and Trevisan, 18, neon ci el specie delle Batteriacee, 1889, 15; De Toni and Trevisan, 18, 1890, 930; Leptotrichia onceps Nannuzzi, in Pollacci, Tratt. Micopat Umana, 4, 1931, 541.) From salva

Appendix III: " Many species of anaerobic, Gram-positive, non space-forming, largely parasitic rods have been described. These are similar in many was s to the species included in Lactobacillus Prévot has arranged these in the following genera. Several are madequately studied and searcely deserve recognition. Some, as indicated, may belong in other genera, e.g., soore formers belonging in genus Clostridium species produce gas in sugar broths or have other characteristics (e.g., motility) that are unusual for the lamilies that include Gram-positive, non-spore form me rods.

### Genus I Eubacterium Prérot (Ann. Inst. Past , 60, 1938, 291)

Non motile, straight or curved rods Vaully occurring singly, in pairs or very short chains. Never show hearching Not capsulated. Gram-positive Anarchine

1 Eulacterium foedans (blein) Prévot (Bacellus foedans Blein, Lancet, 1, 1908, 1832; Prévot, Ann. Inst. Past , 60, 1938, 294 ) From salted ham

2 Eubocterum moni (Haudumy et al ) Prévot (Anacrobe Bacillus, Niesi, Cent f Bikt, I Abt, Ong, 58, 1911, 193, Bacteroides mons Haudurey et al, Dhet d Bact. Path, 1937, 65; Prévot, Ann Inst Past, 60, 1938, 291) From appurative pleuritis

3 Etibacterium rectale Prévot. (Un bacille annérobie, Grooten, Compt rend. Suc Biol, Paris, 102, 1023, 43; Bacteroides rectalis Hauduroy et al., Dict. d. Bact Path, 1927, 72; Prévot, Ann. Inst Past, 60, 1038, 294) From rectal uter.

4 Embacterium obsis Présot (Bacellus B. Obst, Jour Inf Dis. 24, 1919, 159 and 105, Présot, Ann Inst Past 60, 1939, 291) Trom stomach of sardines and from their food (small grusticeans)

- 5 Enhacterium quartum Prévot (Auterob No IV, Rodella, Ztachr. I. Hag. 41, 1902-474, Prévot Ann Inst Past. 60, 1938, 291 : I rum intestine of a child
- 6 Embacterum guntum Prétot.

  (Inneroli No V, Rodelli, Ziecht f
  Hyg. 41, 1962, 135, Prévon, Man de Class et Determ Monographie Inst. Part. 1910, 65 ) From intestine of a child
- 7 Lubacterium ethylicum Prévot (Bueiller grovilis ethylicus Achalme and Rossenthal, Compt. read. Soc. Biol., Paris, 57, 1996, 1925, Prévot, Ann. Inst. Part., 60, 1938, 293.). From a human stomach.
  - S Enhacterium codariris Prévut (see Bacillus cadaceris but; cieux Buday). No sucresoluctived
- 9 Eulacterium torteorius (Delona) Prévat (Parillus tottorius Delona) Cent (Balt), I Abt Orig, C2, 1912, 233, L'ecterales tortuous Borges et al., Minust, Int ed., 1923, 529, Prévot, Ann

<sup>\*</sup> Arranged by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, March, 1915

Inst. Past., 60, 1938, 295.) From human feces.

- Eubacterium aerofaciens (Eggerth)
   Prévot. (Bacteroides aerofaciens Fggerth, Jour. Bact., 30, 1935, 282; Prévot,
   Ann. Inst. Past., 60, 1938, 295.)
   From human feces.
- Eubacterium biforme (Eggerth)
   Prévot. (Bacteroides biforms Eggerth,
   Jour Bact., 30, 1935, 283; Prévot, Ann.
   Inst Past., 60, 1938, 295.) From human feces.
- 12. Eubacterium Imosum (Eggerth)
  Prévot. (Bacteroides limosus Eggerth,
  Jour. Bact., 30, 1935, 295) Prévot, Ann.
  Inst. Past., 60, 1938, 295) Trom human
  leres. Pederson (Jour Bact., 60, 1915,
  478) secured a culture of this species from
  Eggerth, and found that it fermented
  glucose with the production of higher
  fatty (presumably butyric) ends and
  lactic acid The species should probably
  be placed in Butyrbacterium Barker.
  18. Eubacterium disentemate (Mas-
- Budacterium discijormans (Massini, Prévot. (Bacillus discijormans Massini, Zischr f gesammte Exp. Med., 2, 1913, 81. Prévot, Ann Inst Past., 60, 1938, 295)
   From respiratory system and skin
- 14 Eubacterum poecilodes (Roger and Garnier) Prévot (Bacillus poecilodes Roger and Garnier, Bull et Mem. Soc Méd. des Höpitaux Paris, 2, 1906, 870; Prévot, Ann Inst. Past., 60, 1938, 295 ) From intestine
- 15 Bubacterium typhi czanihematici Prévot (see Corynebacterium typhi Topley and Wilson)
- 17 Eubacterum minutum (Tissien) Prévot (Bacillus anaerobieus minutus Tissier, Recherches sur la flore intestinale des nourissons, Paris, 1909; Bacteroides minutus Hauduroy et al., Diet. d. Buet Path., 1937, 64; Prévot, Ann. Inst. Past., 60, 1933, 295) From intestine of breastfed infant.
- 18 Esbacterum parwam (Choukévitch) Prévot. (Coccobacillus anaerobicus parwas Choukévitch, Ann. Inst. Past. £5, 1911, 256; Prévot, Ann. Inst. Past., £0, 1938, 295.) From large intestine of a horse.

 Eubacterium Ientum, (Eggert Prévot. (Bacteroides lentus Eggert Jour. Bact., 30, 1935, 280; Prévot, An Inst. Past., 60, 1938, 295.) From huma foccs.

## Genus II. Catenabacterium Pravi (Ann. Inst. Past., 60, 1938, 231)

Non-motile, straight or curved role Usually grow in long chains or filaments No branching. Not capsulated Gram positive, Anaerobic,

- 1. Catenabacterium helminkoile (Lewkowicz) Prévot. (Dacellus kelms knaides Lewkowicz, Arch. de Méd Exp. 18, 1901, 631; Prévot, Ann. Inst. Past. 60, 1938, 293.) From mouth of bresstfed infant.
- Catenobacterium filamentosum Prévot. (Jungano, Compt. rend. Sor Biol., Paris, 60, 1909, 112 and 122; Prévot, Ann. Inst. Past., 60, 1938, 295) From intestine of a rat.
- 3. Catenabacterium lottui Prévol (Lotti, Ann. Ig. Sper., 19, 1997, 75; Prévot, Ann. Inst. Past., 60, 1933, 28) From human appendix and intestine
- 4. Catenabacterium catenaforme (Egerth) Právot. (Bacteroides caten) formis Eggerth, Jour. Bact., 39, 1933. 286; Právot, Aun. Inst. Past., 60, 133, 236.) From human feces.
- 5. Catenabacterium nigrum (Repzi) Prévot. (Streptobacillus gangrane psinonaris Repaci, Compt. rend. Soc. Bol. Paris, 61, 1910, 410; Prévot, Ann. Ist Past., 60, 1938, 205.) From gangrensu tissuo found in a lung.

# Genus III. Ramibacterium Privol. (Ann. Inst. Past., 60, 1933, 231)

Non-motile, straight or curved ross with frequent branching. Not coped lated. Gram-positive. Anaerobic

1. Ramibacterium ramosum (Veillon and Zuber) Prévot. (Bacillus ramosu Veillon and Zuber, Arch. méd evy et anat. path., 10, 1898, 542; Nocarha ramosa Vuillemin, Encyclopédie Mor log., Paris, 2, Champignosa Parasits, 1931, 132; Actinomyces ramosus Nannuzzi, in Pollacci, Tratt Micopat Umana, 4, 1934, 42, Euiforms ramosus Topley and Wilson, Prine Bact and Immun. 2nd ed., 1938, 358, Hauduroy et al., Diet d. Bact. Path., 1937, 71 regard Bacillus pocciloides (Eubacterium pocciloides) as a synonym; Prévot, Ann Inst. Past. 60, 1938, 296) Commonly found in appendicitis

2 Rambacterum ramocodos (Runcberg) Prévot. (Bacillus ramosondes Runeberg, Arb a d path Inst d Univ Helsingfors, 2, 1908, 271, sec Cent f Bakt, I Abt, Ref, 43, 1909, 655, Prévot, Ann Inst Past., 60, 1938, 296, Fom peritoneal fluid in appendictis

3. Rambacterium pseudoramoium (Distaso) Prévot (Bacillus pseudo ramosus Distaso, Cent f Baki, 1 Abi, Orig, 62, 1912, 441, Bacteroides pseudoramosus Bergey et al, Minual, 1st ed, 1923, 250; Prévot, Ann Inst Past, 60, 1933, 296) From human feces

Genus IV. Cillobscterium Prévot (Ann Inst Past, 60, 1938, 294)

Motile, straight or curved rods Peritrichous Not capsulated Gram-posi-

1. Cillobacterium

. Cillobacterus moniliforme (Repaci) Prévot. (Haculus moniliforms Repact, Compt. rend. Soc Biol, Parts, 61, 1910, 216; Prévot, Ann Inst Past, 60, 1938, 296.) From the respiratory system.

2. Cillobacterium endocarditis (Router and Braunberger) Prévot (Baeille BG, Routler and Braunberger, Compt rend. Soc. Biol., Paris, 115, 1931, 611, Prévot, Ann Inst. Past., 60, 1938, 296.)

From febrile endocarditis
3 Cillobaclerium meningitis Prévot

(Stamm S. V., Ghon, Mucha and Muller, Cent. f. Bakt., I. Abt., Orig., 41, 1906, 145 and 693; Prévot, Ann. Inst. Past., 60, 1938, 297.). From meningstis follow-

ing chronic otitis

4. Cillobacterium spatuliforme Prévot (see Bacillus tenuis spatuliformis Distan). Said to belong to Bacillus welchingroup but no spores observed.

5 Cillobacterium multiforme Prévot (see Bacillus multiformis Distaso). Said to belong to Bacillus welchii group but no spores observed.

Genus V Bifidobacterium Orla-Jensen (Orla-Jensen, Le Lait, 4, 1924, 469; Bifidibacterium (sic) Prévot, Ann Inst Past, 60, 1938, 303.)

Non-motile rods which may be swallen. The ends may be bifurcate or double bifurcate. Gram-positive Anaerobe. This genus is regarded as one of four genera of lactic acid, rod-shaped bacteria by Orla-Jensen, and he states that the organisms in the genus form dextro rotatory lactic acid, It is placed in the Order Actinomicalist by Prévot.

1 Bifidibacterium bifidum (Tissier) Prévot. (Prévot, Ann. Inst. Past., 60, 1933, 303) See Lactobacillus bifidus (Tissier) Holland.

2 Bifidibacterium appendicitis Prévot

(Bacillus & Lotti, Ann Ig Sper, 10, 1909, 75, Prévot, Ann Inst. Past., 60, 1938, 303.) From an infected appendix

3 Bifdibacterium constellatum (White)
Prévot (Boxillus constellatus White,
Jour. Path and Bact., 24, 1921, 69,
Prévot, Ann Inst. Past, 60, 1933,
303) From the intestine of bees.

4 Bifdibacterium intestinalis Prévot. (Bacillus intestinalis luberculiformis Jacobsen Also uses Racillus tuberculiformis and Bacillus tuberculiformis intestinalis, Ann Inst Past , 22, 1903, 315, Prévot, Ann Inst Past , 60, 1938, 303) From feces of an infant

5 Bifdbacterium cornulum (Distruo) Prévot. (Bacillus cornulus Distaso, Cent I Bakt, 1 Abt, Orig, 62, 1912, 413, Bacteroufes cornulus Castellani and Chalmers, Man Trop Med., 1919, 960, Prévot, Ann Inst. Past, 66, 1933, 303 ) From human mouth and intestine.

6 Bifdibacterium bifurcatum Prévot (Bacillus bifurcatus gazogenes Chouké vitch, Ann Inst. Past., 22, 1911, 318; Prévot, Ann Inst. Past., 60, 1938, 393) From mestine of a horse.

#### Genus II. Microbacterium Orla. Jensen \*

(The Lactic Acid Bacteria, 1919, 179.) From Greek mikros, small and M. L. bocterium, a small rod.

Small rods. Non-motile. Gram-positive. Produce lactic acid but no gas from carbohydrates. Surface growth on media is good. Produce catalasc. Usually heatresistant. Found in dairy products and utensils, fecal matter and soil.

The type species is Microbocterium lacticum Orla Jensen.

# Ken to the species of genus Microbacterium.

- I. Acid from starch; survives 85°C for 21 minutes.
- 1. Microbacterium lacticum.
- II. No acid from starch; survives 71.6°C for 2} minutes.
  - 2. Microbocterium flovum.

1. Microbacterium lacticum Orla-Jensen. (The Lactic Acid Bacteria, 1919. 179, Coryncbocterium lacticum Jensen, Proc. Linnean Soc of New So. Wales, 59, 1934, 50 ) From Latin lac, milk: M. L., pertaining to milk.

Small thin rods, 0.3 by 1.0 micron. may have coccus-like appearance. Nonmoule. Granular. Gram-positive. Angular and pallisade arrangements of

cells are characteristic

Agar slant: White or at times slight greenish-vellow growth, adherent

Gelatin: No liquefaction.

Milk: Acid, coagulation variable Natrites usually not produced from nitrates.

Indole not formed

Acid from glucose, fructose, mannose, galactose, maltose, lactose, dextrin and starch. No acid from aylose, arabinose, rhamnose, or raffinose Dextro lactic acid formed.

Catalase is produced

Temperature relations. Minimum 10°C. Optimum 30°C. Maximum 35°C Survives 85°C for 21 minutes in skimmilk.

Aerobic to facultative anaerobic.

Source · From cheese, milking equipment, grass, human and bovine feces

Orla-Jensen (loc. cit., 180-181) identifies the Bacillus acidophilus cultures obtained by him from the Král collection as belonging to this species. The chameters of the Král cultures deviate from the characters of Bacillus acidophilus # given by Moro

Habitot: Human and bovine intestinal tract and probably soil.

2. Microbacterium flavum Orla-Jensen-(Orla-Jensen, The Lactic Acid Bacteris, 1919, 181; Myrobasteriem florum Jensen, Proc. Linnean Soc. of New So. Wales, 59, 1931, 31.) From Latin farms,

yellow. Rods: 0.5 by 1 to pricrons. Granular and therefore some nes confused with micrococci. Non-make. Gram-positive Agar: Surface growth usually yellow

and viscid.

Gelatin: No lique letion

Broth containing 10 per cent salt: Grows as flaky precipitate.

Milk: Slight acidity with no coeguls tion.

Nitrites produced from nitrates

Indole not formed

Acid from glucose, fructose, mannose, galactose, raffinose and mannitol. No acid from xylose, arabinose, rhamnose,

<sup>\*</sup> Arranged by Prof. C. S. Pederson, New York State Experiment Station, General New York, June, 1938; further revision by Dr. M. L. Speck, Baltimore, Maryland, Sept., 1943.

sorbitol, inulin, starch, or salicin Dextro lactic acid formed

Catalase is produced.
Temperature relations · Optimum 30°C.
Maximum 35°C. Manmum 20°C. Survives 71.6°C for 24 but not 10 minutes

Aerobic to facultative anaerobic Source: From milk, cheese, butter, milking equipment, bovine feces

Mabitat · Bovine intestinal tract and

probably soil

Appendix: While Orla-Jensen has

placed the following species in the genus Microbacterium, the description is incomplete and the organism differs from the other species in the genus in several important characters. Therefore it is placed in this appendix. Microbacterium liquificatens Orla-Jen-

son. (Orla-Jonesn, The Lactic Acid Bacteria, 1919, 182; Corynebacterium Iquefaciens Jensen, Proc. Linnean Soc of New So. Wales, 59, 1934, 49) From Latin liques, to be liquid; facto, to make. Morphologically resembles Micro bacterium lacticum.

Agar. Surface growth is faint yellowishgreen.

Gelatin: Liquefied.

Milk: Rennet congulation in 1 to 3

weeks; the case in is peptonized gradually. Catalase is produced.

Temperature relations: Optimum 30°C, Withstands heating to 80°C.

Action on carbohydrates has not been described, Orla-Jensen states that very little acid is produced.

Source: From milk and more frequently from cheese.

Habitat Presumably dairy products.

Norn The following species may belong here Bacterium cassolyticum Kitahara, Jour Agr. Chem Soo Jopan, Tokyo, 14, 1038, 121 and 1461. A Granpositive, acid-forming and proteolytic rod said by the author to be related to Microbacterium liquefactens

### Genus III. Propionibacterium Orla-Jensen \*

(Cent. f. Bakt., 11 Abt., 22, 1909, 337.) From M. L., propionic, and bacterium, 1 small rod or stick.

Non-mottle. Non-spore-forming. Gram-positive bacteria growing under ansenbie conditions in neutral media as abort diphtheroid rods, sometimes resembling streptococci; under scrobic conditions with heavy inoculum growing as long, irregular, elub-shaped and branched cells. Metachromatic granules demonstrable with Albert's stain. Ferment lactic acid, carbohydrates, and polyalcohols with the formation of propionic and acetic acids and carbon dioxide. As a rule strongly catalase positive, sometimes weakly so. Strong tendency towards anaerobiosis; development very slow, macroscopically visible colonies cenerally not discernible in less than 5 to 7 days. † Nutritional requirements complex. Development best in yeast extract media with addition of lactates or aimple carbobydrates. Optimum temperature 30°C. Found in dairy products, especially hard cheeses.

The type species is Propionibacterium freudenreichti van Niel.

## Key to the species of genus Propionibacterium.

- I In yeast extract-glucose media growth occurs in the form of small streptococci-Dirty eream-colored growth in stabs, with slight surface growth of same color. Sucrose and maltose not fermented.
  - A Not fermenting lactose.
- 1. Propionibacterium freudenreichii.
- B. Fermenting lactose.
- · 2. Propionibacterium shermanii.
- II In yeast extract-glucose media growth occurs in the form of typical short rods of diphtheroid appearance. Distinct surface growth in stabs. Sucrose and maltose are fermented.
  - A. Growth brownish-red.
    - Fermonts raffinose and mannitol, but not sorbitol.
    - 3. Propionibacterium rubrum.
    - 2. Ferments sorbitol, but not raffinose and mannitol.
      - 4. Propionibacterium thoenii.
  - B. Growth in stab cream-colored.
    - 1. Surface growth cream-colored. a Ferments I-arabinose and rhamnose.
      - 5. Propionibacterium zeac.
    - 2. Surface growth yellow to orange.
      - a. Growth in hauid media flocculent, as if agglutinated.
      - 6. Propionibacterium peterssonii.
      - aa. Growth in liquid media dispersed, smooth.

\* Revised by Prof. C. B. van Niel, Hopkins Marine Station, Pacific Grove, California, June, 1938; further revision by Prof. Van Niel, January, 1944.

† In an atmosphere containing 5 per cent carbon dioxide, growth is enhanced both aerobically and anaerobically. Contrary to the claim made by Krebs and Eggleston (Biochem Jour, 35, 1941, 676) a differential effect of carbon dioxide tension on acrobic and anacrobic development has never been observed.

b. Do not ferment dextrin, glycogen or starch.

7. Propionibacterium jenzenii.
8. Propionibacterium rofinozaceum.

bb. Ferments dextrin, glycogen and starch.

9. Propionibacterium technicum.

111 In yeast extract-glucose media growth occurs in the form of highly irregular eells, giving the appearance of involution forms. Distinct surface growth in stabs. Both d- and l- arabinose are fermented.

A. Involution forms large, swollen spheres. Surface growth orange-yellow.

Does not ferment xylose and rhamnose.

10. Propionibacterium grabinosum.

Involution forms long, irregular rods. Surface growth eream-colored. Ferments xylose and rhamnese.

11. Propionibacterium pentosaceum.

1 Proplontbacterium freudenretcht van Niel. (Bacterium acidi propionicia, von Treudenreich and Orls-Jenen, Cent f. Bakt., 11 Abt., 17, 1906, 532; Bacterium acidi propionici var. juicum Thom and Allemann, Cent. I. Bakt., 17 Abt., 25, 1910, 22; van Niel, The Propionic Acid Bacteria, Haarlem, 1928, 162, Werkman and Brunn, Jour. Bact., 57, 1973, 373.) Named for Edward von Freudenreich, the Saiss Insteriologist, who isolated this species

Description taken from van Niel, and

Werkman and Brown

Small spherical cells, 0.5 to 0.6 micron, meetly in pains and slort chains. Lattle difference in morphology between growth from ansecrobic solid media, and neutral or solid liquid media. Archide growth irregular, club-shaped and branched, beg rate. Non motule. Slow meta-chowatte granules. Gram positive

Yeart gelatin lactate stale; No liquefaction.

Yeast aget factate stale Dirty grapishereamy dearl quient in stale; very slight surface growth of same color.

Big of motion Distantly turbs with grand creams, pay softment

Late in rollieblight development, fairs reflection. Not engulated

Catalain practice.

National set produce I from potentee formers letter and pyruse ands, glycent, dlydn symes on, glume, from tose, mannese and galactose with the formation chiefly of propionic and acetic acids, and carbon dioxide.

Acid Irom crythritol, adonitol, inositol and esculin. No acid from amygdalin, de and Larabinese, destrin, dutcitol, glycogen, inulin, lactore, maltese, mannitol, meletitore, melibize, precitol, milinore, riammere, sucrese or syllese.

Anaerobic, Distinctive characters: Inability to ferment any of the disacclarides when inoculated in yeast extract-sugar media.

Source From thiry products; raw market milk, Swiss cheese.

Habitet Dairy products.

 Propionibatterium abermanii van Nief (Hosterium neuft propionief d, Sherman, Joar, Dact, e., 1921, 287; van Niel, The Propionie Acid Basteria, Haarlem, 1928, 1931, 490 (Narsad for Jurn Bact., 25, 1933, 490). Narsad for J. M. Mierman, the American Lateriolcent, who is later this agreerer

Description taken from van Niel, and Werkman and Brown.

Shall spheroal criti, 0.5 to 0.6 mirror, restly in pairs and short chains. Little difference in neighbor to be tween growth from a merchale with mode and neutral countries. Coloring on the restle growth arrelate, Chicaloguel, and transfed rule. Non traile the metallic production of the chain of the chai

Probably from silage. Habitat: Dairy products.

 Propionibacterium peterssonii van Niel. (Bacterium acidi propionici c, Toili-Petersson, Cent. f. Bakt., II Abt., 24, 1909, 333; van Niel, The Propionic Acid Bacteria, 1928, 163; Werkman and Brown, Jour. Bact., 26, 1933, 406.) Named for Gerda Troili-Petersson, the Swedish bacteriologist, who isolated this organism.

Description taken from van Niel, and Werkman and Brown.

Cells in neutral media spherical, 0.8 micron, occurring as short streptoeocci in clumps In carbohydrate media which turn acid during development, rod-shaped cells in clumps, 0.8 by 1.5 to 2.0 microns. Aerobic growth, heavily swollen and branched rods. Non-motile. Show motachromatic granules. Gram-positive.

Yeast gelatin-lactate stab Ne liquefaction

Yeast agar-lactate stab: Cream-colored growth, dry and wrinkled, resembling that of Mycobacterium spp.

Liquid media: No turbidity, sediment a coherent layer, ercam-colored

Litmus milk: Acid, coagulated.

Catalase positive; aerobically developed growth very slightly so.

Indole not formed.

Nitrites not produced from nitrates. Ferments lactic and pyruvic acids, glycerol, dihydroxyacetone, glucose, fructose, mannose, galactose, sucrose, maltose and lactose with the formation of propionic and acetic acids, and carbon dioxide

Acid from esculin and saliem. No acid from d. and I arabinose, cellobiose, devtrin, dulcitol, glycogen, inulin, perseitol, pectin, raffinose, rhamnose, sorbitol, starch or xylose.

Less anaerobic than Propionibacterium freudenreichii and Propionibacterium shermanii.

Distinctive character Growth in liquid media in clumps, giving the cul-

tures the appearance of agglutinated bacteria. So far, the only species among the propionic acid bacteria possessing this characteristic.

Source: From cheese and soil. Habitat · Dairy products.

7. Proploalbacterium jensenii van Niel. (Baeterium acidi propionici b, von Freudenreich and Orla-Jensen,Cent f. Bakt., II Abt., 17, 1906, 532; van Niel, The Propionic Acid Racteria, 1923, 163, Werkman and Brown, Jour. Bat., 25, 1933, 404.) Named for Prof. S. Orla-Jensen, the Danish bacteriologist, who isolated this organism.

Description taken from van Niel, and

Werkman and Brown.

In neutral media spherical to short rod-shaped cells, often in pairs or short chains, 0.8 by 0.8 to 15 microns, of typical diphtheroid appearance. Morphology little influenced by developing acidity. Aerobic growth, Irregular long rods, swollen and branched. Non-motit Metachromatic granules. Gram-positive.

Yeast gelatin-lactate stab: No lique-

Yeast agar-lactate stab: Cream-colored growth in stab, orange-yellow, dome-

shaped surface growth.

Liquid media: Turbid in early stages;
cream-colored, smooth sediment.

Litmus milk: Coagulated, acid. Catalase. Strongly positive.

Indole not formed.

Nitrites not produced from nitrates
Ferments lactic and pyruvic acids,
glycerol, dihydrovyacetone, glucose, fructose, mannose, galactose, sucrose, maliose, lactose and sometimes raffiness and
mannited with the formation of proposic
and acetic acids, and carbon diovide

Acid from adonttol, arabitol, crythrilol, esculin, inositol and trehalose. No acid from arabinose, cellobiose, devtrin, dulctol, glycogen, inulin, perseitol, pectan, rhamnose, salicin, sorbitol, starch or vylose. Less anaerobic than Propionibacterium freudenreichii

Distinctive characters Morphologically similar to Propionibacterium rubrum and Propionibacterium them:
from which it is chiefly distinguished by the failure to produce a red pigment under anaerobic conditions. The yellow surface growth distinguishes Propionibacterium penetui from Propionibacterium zece, as also the inability of the former to ferment I-arabinose and rhamnose.

Source · From cheese and butter. Habitat: Dairy products

8 Proplonibacterium raffinosaceum Werkman and Kendall. (Propionibacterium jensenii var raffinosaceum van Niel, The Propione Aeld Bacteris, 1928, 162, Werkman and Kendall, Iowa State Coll Jour. Sci., 6, 1031, 17; Werkman and Brown, Jour Bact. 26, 1933, 402) From M. L. raffinosum, the sugar raffinose.

Description taken from van Niel, and Werkman and Brown

Cells in neutral media spherical to short rod-shaped cells, 0.8 by 0.8 to 1.5 microns, of typical diphtheroid appearance. In media in which acid is produced the cells are somes hat longer rodshaped, to 2 microns in length. Aerobic growth irregular, long rods, swollen and branched. Non-motile Metachromatic granules. Gram-positive.

Yeast gelatin-lactate-stab. No liquefaction

Yeast agar-lactate-stab Cream-colored growth in stab; distinct, orange-yellow surface growth

laquid media. Turbid in early stages, cream-colored, smooth sediment

Litmus milk. Coagulated, acid Catalase positive; aerobically grown

only very slightly so Indole not formed.

Nitrites not produced from nitrates

Ferments lactic and pyruvic acids, glycerol, dihydroxyacctone, glucose, fructose, mannose, galactose, cellobiose, malt-

ose, lactose, sucrose, raffinose and mannitol with the production of propionic and acetic acids, and carbon dioxide.

Aead from adonitol, amygdalin, arabitol, erythritol, esculin, inositol, meleritose, saliein and trehalose No seid from d-and l-arabinose, devtrin, didicitol, glycogen, runin, melibiose, perseitol, peetin, rhamnose, sorbitol, starch or xylose.

Less anacrobic than Propionibacterium

Distinctive characters: Differs from Propumbacterium generus in its somewhat greater length and the ability to ferment cellobiose and salicin; the behaviour of Propiombacterium jensenii towards raffinose and mannitol is not constant, and hence cannot be used as a differential character Werkman and Kondall have reported different agglutination reactions for Propionibacterium jensenii and Propionibacterium raffinosaccum

Source From buttermilk. Habitat: Dairy products.

9 Propionibatterium technicum van Niel (Van Niel, The Propionic Acid Bacteria, 1923, 164, Werkman and Brown, Jour Bact, 26, 1933, 401) From Greek technicus, technical, M. L., of industrial sumificance.

Description taken from van Niel

In neutral media spherical cells, 08 maron, in parts and short chains In acid media short rods, 06 by 10 to 15 merons, often in pairs, with typical diphtheroid appearance. Aerobic growth in the form of irregular long rods, swollen and branched. Non-motile Metachromatic granules. Gram-positive.

Yeast gelatin-lactate-stab: No liquefaction.

Yeast agar-lactate-stab: Cream-colored development in stab, with distinct 3 cllow auriace growth.

Liquid media. Turbid in early stages, eream-colored, somewhat florculent sediment. Litmus milk: Coagulation, acid.

Catalase positive.

Indole not formed.

Nitrites not produced from nitrates. Ferments lactic and pyruvic acids, glycerol, dibydroxyacetone, arabinose, glucose, galactose, fructose, mannose, dectorin, glycogen and starch with the formation of propionic and acetic acids, and carbon dioxide

Acid from esculin salicin and mannitol. No acid from dulcitol, inulin or xylose. Anacrobic, but less so than Propionibacterium freudenreichii.

Distinctive characters: The ability to ferment the polysaccharides dextrin, glycogen and starcb.

Source: From Edam and Tilsit cheese. Habitat Dalry products

10. Propionibacterium arabinosum Hitchner. (Hitchner, Jour. Bact, 23, 1932, 40; 28, 1934, 473; Werkman and Brown, Jour Bact, 26, 1933, 410.) From M. L. arabicum, gum Arabic; M. L. arabinosum, arabinose.

Description of culture isolated by Hitchner.

Cells in acutral lactate media spherical, 0.8 micron, in pairs and short chains. In acid media swollen spheres and ellipsoidal cells occur, mostly 2.0 by 3.0 to 3.5 microns, often in pairs and short chains. Non-motile. Metachromatic granules Gram-positive.

Yeast gelatin-lactate-stab: No lique-

Yeast sgar-lactate-stab: Cream-colored growth in stab, with distinct orangevellow surface growth.

Liquid cultures: Turbid in early stages, cream-colored, smooth sediment.

Litmus milk: No coagulation. Catalase very slightly positive.

Indole not formed.

Nitrite production not recorded.

Ferments lactic and pyruvic acids, glycerol, dihydroxyacetone, d- and 1-arabinose, glucose, galactose, fructose, mannose, cellobiose, maltose, sucrose,

mffinose and mannitol with the production of propionic and acetic acids, and carbon dioxide.

Acid from sorbitol. No acid from dulcitol, xylose, rhamnose, salicin or inulin.

Anserobic, but less so than Propionibacterium freudenreichii.

Distinctive characters: The development of spherical involution forms in acid media, the almost complete absence of catalase, the ability to ferment both d- and l-ambinose, but not xylose and rhamnose.

Source: Not definitely stated.

Habitat : Dairy products.

Note: The strain obtained from Dr. E. B. Fred produced only minute amounts of acid from lactose and starch. It is questionable whether these carbohydrates are fermented.

11. Propionibacterium pentosateum van Neil. (Bacilius acidi propionic von Freudenreich and Orla-Jensen, Ceaf. f. Bakt., 11 Abt., 17, 1906, 522; van Nei, Tho Propionic Acid Bacteria, 1923, 163; Werkman and Brown, Jour. Bact. £, 1933, 408.) From M. L. pentosum, a pentose.

Description taken from van Niel, and

Werkman and Brown.

In neutral hetate media cells spherical, 0.8 micron, in pairs and short chaits. In media developing acidity long, irregular rods, swollen and branched, to 3 to 4 microns in length. Acrobic growthings ular, swollen and branched, long rods. Non-motile. Metachromatic granules. Gram positive.

Yeast gelatin-lactate stab: No liquefaction.

Yeast agar-lactate stab · Cream-colored development in stab, with abundant, cream-colored surface growth.

Liquid media: Turbid in early stages; smooth, creamy sediment, ropy.

Litmus milk: Coagulated, acid.

Catalase: Slightly positive. Indole not formed. Nitrites and free nitrogen produced from nitrates.

Ferments lactic and pyruvic acids, glycerol, dhydrovyacetone, d. and larahinose, xylose, rhamnose, glucose, glactose, fructose, roannose, cellobiose, lactose, maltose, sucrose, raffinose, manniol and sorhitol with the formation of propionic and acotic acids, and carbon diovide.

Acid from adoútol, arabitol, erythritol, esculin, inositol, saliein and trehalose No acid from dextrin, duleitol, glycogen, inulin, perseitol or pectin.

Anserohic, but less so than any of the other species of the genus

Distinctive characters: The formation of long, red-shaped involution forms in acid media; the absence of pigment production, and the ability to ferment dand l-arshinose, rhamnose and xylose

Source From Emmental cheese Habitat; Dairy products.

Appendix: Cultures of the following species have not been available for study It is probable that these duplicate previously described species

Propionibacterium amyloaceum var. au-

ranticum Sakaguchi, Swasaki and Yamada. (Bull. Agric Chem. Soc. Japan, 17, 1941, 13.) From cheese. Resembles Propionibacterium pentosaceum elosely.

Propionibacterium coloratum Sakaguchi et al. (loc. cit.). From cheese. Reserobles Propionibacterium thoenii.

Prepionibacterium globosum Sakaguchi et al. (loc. cit.). From cheese. Resembles Propionibacterium shermanii. Said not to ferment glycerol and erythritol.

Propionibacterium japonicum Sakaguchi et al (loc. cil.). Froro cheese. Said not to ferment glycerol and erythritol.

Propionibacterium orientum Sakaguchi et al. (loc cit.). From cheese. Ferments l-arahinose. Resembles Propionibacterium shermanii.

Janoschek (Cent. f. Bakt., II Aht., 106, 1944, 321) has suggested a key for the identification of the species in this genus. This is based on chromogenesis and cultural characters I fie recognises three additional species: Proprointecterium case, Propriontalectrium paint fosum and Propionibacterium paint counseum.

### Genus IV. Butyrihacterium Barker and Haus.\*

(Jour. Bact., 47, 1944, 301.) From the chemical term, butyric and M. L. bacterium, a small rod.

Non-motile, anaerobic to microserophilic, attaight or slightly bent rods. Granpositive. Ferment carbohydrates and lactic acid forming acetic and butyric scits, and carbon diovide. Generally catalase negative but sometimes weakly positive Intestinal parasites.

The type species is Butyribacterium rettgeri Barker and Haas.

 Butyribacterium rettgerl Barkerand Haas. (Strain 32, Lewis and Rettger, Jour. Bact., 40, 1940, 298; Barker and Haas, Jour. Bact., 47, 1944, 303.) Named for L. F. Rettger, The American hacteriologist.

Rods: Straight or eligibily bent, noncapsulated. 0.7 by 2 3 microns. Occur singly, in pairs and short chaine. No branched cells observed hut some cells have ewellen olub-shaped ends. Nonmotile. Gram-positive.

Glucose-cysteine agar: Colonies circular, entire or finely irregular margin, translucent, often with opaque center, grayish-white with yellowish tinge, coavex when small, later umbonate, glistening, smooth, finely granular. Develop slowly attaining a diameter of 1.5 mm in 7 days.

Tryptone-yeast extract-lactate agar: Colonies similar to above except larger (2 mm in 4 days at 37°C). Pulvinate rather than umbonate in cross sections.

Glucose-cysteine-broth: Abundant turbidity and sediment No pellicle.

Agar stab (King and Rettger's medium, Jour. Bact., 44, 1942, 302): Heavy growth in 2 days. Gas production often causes slight splitting of agar.

Acetic and butyric acid and CO2 pro-

duced from glucose and maltose. Occasionally a small amount of visible gas is produced. Lactic acid fermented readily without visible gas. Ambines, xylose, lactose, sucrose, trehalose, thamnose, mannitol, sorbitol, dulcitol and elycerol are not fermented.

Not proteclytic.

Indole and hydrogen sulfids not formed.
Temperature relations: Optimum 37°C.
Maximum 40 to 45°C. Minimum 15°C
Generally catalase negativs.

Anaerobic. Source: From intestinal contents of s

white rat.

Hahitat: Presumably found generally in the intestine of mammals.

Notes: Pederson (Jour. Bact., 50,1915, 478) has found that cultures of two species described by Eggerth (Jour. Bact., 50, 1935, 289 and 290) produce higher fatty (presumably butyric) acids and lactic acid from glucose. These are named Bacteroides avadus and B. limesty Eggerth. Probably these species belong in the genus Butyribacterium.

Bacillus cadaveris bulyricus Buds (Cent. f. Bakt., I Abt., 24, 1898, 374) may also belong in this genus.

<sup>\*</sup>Prepared by Prof. C. S. Pederson, New York State Experiment Station, Geneva, New York, January, 1945; reviewed by Dr. H. A. Barker, Berkeley, California.

#### FAMILY VIII. CORYNEBACTERIACEAE LEHMANN AND NEUMANN.

#### (Bakt Dag., 4 Aufl., 2, 1907, 500.)

Non-motile (motile in Listeria) rods, frequently banded or beaded with metachromatic granules. May show marked diversity of form. Branching cells have been observed in a few species but these are uncommon. Generally Gram-positive but this reaction may vary depending on the nature of the cells. Where pigment is formed, it is grayish-yellow to orange or pink in color. Aerobie to microacrophilic. Anaerobic species have been reported. Gelatin may be liquefied and nitrites may be produced from nitrates. Animal and plant parasites and pathogens. Also from dairy products, soil and water.

### Key to the genera of family Corynebacteriaceae.

1 Aerobic to microacrophilic, non-motile (or questionably motile) rods which are variable in form Animal and plant parasites and pathogens, with some from dairy products, soil and water.

Genus I. Corynebacterium, p 381.

 Small aerobic rods with 1 to 4 flagella. Causes a monocytosis in warm-blooded animals.

Genus II Listeria, p 408

 Microaerophilic, non-motile rods to long filaments Pathogenic on warm-blooded animals.

Genus III. Erysipelothrix, p 410.

# Genus I. Corynebacterium Lehmann and Neumann.\*

(Lehmann and Neumann, Bakt Diag, 1 Aufl, 2, 1896, 300, Corynethriz Czaplowski, Deutsche med Weinselr, £6, 1900, 723, Corynemona Orla-Jensen, Cent I, Bakt., II Abt, £2, 1900, 311, Corynobacterum Enderlein, Stither Gesell, Naturi, Freunde, Berlin, 1917, 309, Plecamobacterum Low, Wiener kim Wehnschr, 53, 1920, 730. From Greek koryne, cilul and M L bacterum, a small roll.

Slender, straight to slightly curved rods, with irregularly stained aegments or granules. Frequently show pointed or club-shaped swellings at the ends Snapping division produces angular and talisade (peeket fence) arrangements of cells Non-motile with possible exceptions as stated in the text. Gram-positive to variable, sometimes young cells and sometimes old cells being Gram-negative Granules invariably Gram-positive. Generally quite serobic, but microscrophile or even anaerbic species occur. Catalase positive They may or may not liquefy gelatin, and may or may not produce intrites from situates. They may or may not ferment sugars, but they seldom produce a high seculty. Many species oudine glucose completely to CO<sub>2</sub> and H<sub>2</sub>O<sub>3</sub> without producing visible gas. Some pathogenic species produce a powerful evotorin. This group is widely distributed in asture. The lest known species are parasites and pathogens on man and domestic animals. Other species have been found in birds and insects and the group is probably more widely distributed in the animal kingdom than thas. Several species are well howen plant pathogens while still other common species are found in dury products, water and soil

The type species is Corynebacterium diphtheriae (Flügge) Lehmann and Neumann.

Rearranged by Prof E. G. D. Murray, McGill University, Montreal, P. Q. Canada and Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, March, 1918, completely revised by Prof. E. G. D. Murray, Montreal, Prof. Robert S. Breed, Geneva and Prof. Walter H. Burkholder, New York State College of Agriculture, Hickae, New York, February, 1915.

## Key to the species of genus Corynebacterium.

- I. From human sources.\* Non-motile.†
  - A. Aerobic. No liquefaction of gelatin.
    - Acid from glucose and usually maltose and galactose. Usually no acid from sucrose. Causes diphtberia.
      - 1. Corynebacterium diphtheriae.

- 2. Not as in 1.
  - a. No acid from carbobydrates.
  - 2. Corynebacterium pseudodiphtheriticum.
  - aa. Acid from glucose and sucrose.
  - b. Highly pleomorphic, varying from cocci to rods.
    - 3. Corynebacterium enzymicum.
      bh. Rods with polar staining with club forms, diphtheroid in appearance.
      - 4. Corumebacterium xerose.
    - bbb. Rods as above but characteristic salmon pink growth on congulated blood scrum.
- 5. Corynebocterium hoagii.
- B. Mieroaerophilic to anacrobic. Growth feeble or none at all on gelating.

  6. Coruncocterium ocnes.
- · II. From domestic and laboratory animals. Non-motile.
- A. Acid from glucose.
  - Grows poorly if at all on ordinary gelatin and sgar. Slow liquefaction of serum gelatin and coagulated blood serum. Causes suppurative processes in cattle, swine, and other nnimals.
    - 7. Corunebacterium pyogenes.
  - 2. No liquefaction of gelatin or blood serum. Grows poorly, if st all, op ordinary celatin and mar.
    - a. Cause of pyelonephritis in cattle.
    - 8. Coryneboclerium renale.
    - aa. Found in cascous nodules resembling those of tuberculosis. Found in sheep, horses and some other animals.
      - 9. Corynebacterium pseudotuberculosis.
    - ass. From caseous nodules in mice.
      - 10. Corynebacterium kutscheri.
  - asaa. Causes a septicemia in mice.
  - 11. Corynebacterium murisepticum.
  - B. No acid from carbohydrates. No liquefaction of gelatin.
    - From milk and bovine udder.
       Corunebacterium bovis.

\* Habitat relationships are used because comparative studies of the species in the

genus are still completely lacking.

† The reports of motile species in this genus present a puzzling problem, particularly as the motile species of plant pathogens placed in the genus are polar flagfilate. Some students of the group feel that, if motile species really exist, they should be placed in a separate genus. Others feel that a more careful study of the described polar flaggilate species will show that these species really belong elsewhere. Where authors have reported motility, this fact is indicated in the text. It should be noted that similar uncertainties exist in regard to described cases of motility among the streptogene and lactopacilli.

- 2. From pneumonia in foals.
- III. From insects. Non-motife.
  - A. No acid from carbohydrates. Slow liquefaction of gelatin.
- IV. Plant pathogens. Non-motile.
  - A. Nitrites not produced from nitrates
    - 1. Colonies cream-colored. Slow liquefaction of gelatin.
      - a Bluish granules in growth. Attacks alfalfa.
        - 15. Corunebacterium insidiosum.
      - aa. No bluish granules Causes ring rot of potatoes. 16 Corynebacterium sepedonicum.
      - 2. Colonies yellow
        - a. No liquefaction of gelatin Causes a wilt and canker of tomatoes.
        - 17. Corunebacterium michiganense.
    - B. Nitrites produced from nitrates. Slow or no liquefaction of gelatin.
      - 1. Colonies yellow. Attack members of the grass family.
        - 13 Corunebactersum rathavi. 19 Corynebactersum agropyri.

13. Cormebacterium equi.

14. Corynebacterium paurometabolum.

- 2. Colonies orange Parasitic on sweet peas, etc.
- 20 Corunebacterium fascians.
- V. From soil and water Laquefaction of gelatin in all cases but sometimes very slow (7 weeks).
  - A. Acid from glucose Non-motile.
    - 1. Nitrites not produced from nitrates
      - 21. Corynebacterium helvalum.
    - 2. Nitrites produced from nitrates
      - a. Collulose digested. 22 Corunebacterium fimi.
      - as. Cellulose not digested.
  - 23 Corynebacterium tumescens. B. No seid from glucose. Some indication of motility in No 25.
    - 1. Cells coccold to short, straight or curved rods
      - 24. Corynebacterium simplex. 2. Young cells curved rods in parallel bundles These may grow out into
        - filaments with branching. 25 Corynebacterium filamentosum.

1. Corynebactertum dishtherise (Flügge) Lehmann and Neumann crosporon diphthericum Kleba (prototype), Verhandl. d. Congr. f innere Med., 2, 1883, 143; die Klebs'seben Stabchen, Löffler, Mitteil. n. d. kaiserl Gesundheitsamte, 1881; Bacillus diphtheriae Flügge, Die Mikroorganismen, 2 Aufl., 1886, 223; Paeinia lorfflers Trevisan, I generi e la specie delle Batteriacee, 1889, 23; Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1806, 350;

Bactersum diphtheriae Migula, Syst. d. Bakt., 2, 1900, 499.) From Greek diphthera, a pieco of leather; M. L., the disease diphtheria.

Common name Diphtheria bacillus; Klebs-Loeffler bacillus.

Rods, varying greatly in dimensions, 0.3 to 0 S by 1.0 to 8 0 microns, occurring singly. The rods are straight or slightly eurved, frequently swollen at one or both ends The rode do not, as a rule, stain uniformly with methylene blue but

show alternate bands of stained and unstained material and in addition one or more metachromatic granules which are best shown by special stains. Non-motille. Gram-positive but not intensely so in older cultures.

Gelatin colonies: Slow development. Very small, gravish, lobulate.

Gelatin stab · Slight growth on surface and scant growth in stab. No liquefaction.

Agar slant: Scant, grayish, granular, translucent growth, with irregular margin.

Blood-tellurate media: Produces gray to black colonies.

Colony forms: Smooth (S) colony form: Round and umbonato or convex, with even margin and smooth surface. Opaque when viewed by transmitted light, glisteaing and somewhat moist in appearance when viewed by reflected light Colonies about 1 to 3 mm in diameter. Growth frequently slowed or iahibited by the presence of potassium tellurite in the medium.

Rough (R) colony form Flat, margin is very irregular. Surface is pitted and very uneven. Very little light reflected from surface Translucent when viewed by transmitted light. Colonies about 1 to 5 mm in diameter.

Intermediate colony forms: Severol colony forms are found in this group since the term includes all forms between the pure S form and the pure R form. Sr forms very nearly approach the S colonies and the RR forms nearly approach the pure R forms. The SR form shows properties distinct from either the S or R forms. The colonies are 3 to 5 mm in diameter. The margin usually shows indentations. The surface is raised but not convex; it may be nearly level or show a central elevation surrounded by a concentric depression and elevation.

Dwarf (D) colony form: Colonies very small, about 0 2 mm or less in diameter. Margin round and even. Surface convex.

All of the above colony forms have been

isolated from cases of diphtheria (Morton, Jour. Bact., 40, 1940, 768 ff.).

Broth: Uniform turbidity produced by S form, pellicle produced by SR form, sediment produced by the R form Litmus milk: Unchanged.

Potato: No visible growth.

Blood scrum: Growth grayish to creancolored, moist, smooth, slightly raised, margin entire. May be bright yellow or occasionally reddish (Hill, Sci., 17, 193, 375).

Indole is not formed.

Nitrites are produced from aitrates.

All strains form acid from glucose and fructose; some strains also ferment galactose, maltose, sucrose, dextrin and glycerol.

Does not hydrolyze urea (Merkel, Cent. f. Bakt., I Abt., Orig., 147, 1941, 398).

A highly poisonous exotoxin is produced in fluid media. This toria represents the principal disease-producing agency of the organism. Toxin production may fail in otherwise typical strains.

A highly potent antitorin can be produced by repeated injection of toxin into experimental antimals. The antitoring possesses both curative and protective properties.

Scrological types: In a study of 26 strains of Corynchacterium diphthreat Murray (Jour. Path. and Bact., 41,135, 439-45) was able to classify 228 strains into 11 serological types and 22 strains remained unclassified (Morton, Biet Rev., 4, 1940, 195).

MeLeod et al. (Jour. Path. and Baé, MeLeod et al. (Jour. Path. and Baé, 54, 1931, 667; ibid., 58, 1933, 169; Lacet. I, 1033, 293) describe three types which have been confirmed by other worker, these are distinguishable by colony form of MeLeod's blood-tellurite medium, they are antigenically different with subtypes, there is some difference betwee their toxins (Etris, Jour. Inf. Dis. 58, 1934, 220) and the severity of disease is associated with the type.

Corynebacterium diphtheriae type graus

grous with dark gray, daisy-head colonies; ferments devtrin, starch and glyco gen; is not hemolytic, has very few small metachromatic granules; forms a pellicle, granular deposit and there is an early reversal of pH in broth.

Corpnebacterium diphtheriae type mitas grows in convex, black, shiny, entire colonies; no fermentation of stareb and glycogen and is variable with destrin, hemolytic; metachromatic granules are prominent; diffuse turbidity, infrequent pellicle and there is a late reversal of pH in broth.

Corpnobatterium diphtheriae type insternedius grows a small, fat, umboante colony with a black center and slightly crenated periphery; not hemotylet, bar ring of bacilli is accentuated, there is no fermentation of starcli and glycogen, and is variable with dextrin, forms no pelibele, a fine granular deposit and there is no reversal of pH in broth.

Ten years of observations in all parts of the world have shown (McLeod, Dact Rev, 7, 1943, 1) that a small percentage of strains does not correspond closely to may of these three types Variant strains are found most frequently in regions where the diphtheria is of mild or moder atte severity.

Aerobie, facultative

Optimum temperature 34° to 36°C Grows well at 37°C.

Source: Commonly from membranes in the platyny, laryny, trachea and nose in human diphtheria; from the seemngly healthy pharynx and nose in carriers, occasionally from the conjunctiva and infected superficial wounds Found occasionally infecting the nasal passages and wounds in horses. Has been described from natural diseases in foul.

Habitat: The cause of diphtheria in man. Pathogenie to guinca pigs, Littens and rabbits. For netion on other animals see Andrews et al., Diphtheria. London, 1923, 170 ft.

2. Corynebacterium pseudodiphtherit-

lcum Lehmann and Neumann. (Bacillus der pseudodiphtherie, Locffler, Cent. f. Bakt . 2. 1887, 105, G von Hofmann-Wellenhof, Wien. med. Wochenschr., 58, 1888, 65; Lehmann and Neumann, Bakt Diag , 1 Aufl., 2, 1896, 361 , Bacillus pseudodiphthericus Kruse, in Flügge, Die Mikroorganismen, 3 Aufl. 2, 1896. Bacterium pseudodiphtheriticum Migula. Syst. d. Bakt, 2, 1900, 503; Mycobacterium pseudodiphthericum Chester, Man. Determ Bact., 1901, 355. Bacillus hoffmanss (sic) Holland, Jour. Bact , 5, 1920, 215; Corynebacterium hoffmans: (sic) Holland, ibid., 220; Corynebacterium pseudodiphtheriae Holland, thid , Corynchacterium pseudodiph. therseum Bergey et al , Manual, 2nd ed . 1925, 393 ) From Greek pseudus, a falsehood; M. L , the disease diphtheria

Common name: Pseudodiphtheria ba-

Excellent bistorical discussions of this and related organisms are given by Bergey. Comparative Studies upon the Seude-diphthera or Hofmana's Bacillus, the Nerosis Bacillus, and the Loeffer Bacillus Contrib from Lah of Hyg, Univ of Penn., No. 2, 1808, 19-5, and by Andrewes et al, Diphtheria Landon, 1923, 383-388

Rods, with rounded ends, 0 3 to 0 5 ly
08 to 15 microns, fairly uniform in
size, without swollen ends Not barred
but even staining interrupted by transverse, medial unstained septum; granules
usually absent Non-motile. Grampositive

Gelatin colonies Small, grayish to cream-colored, smooth, homogeneous, entire.

Gelatin stab Slight surface growth with little growth in stah No liquefaction

Agar colonies. Opaque, grayish to cream-colored, smooth, homogeneous, entire

Agar slant Moist, smooth, white to cream-colored, entire growth

Locffler's blood serum As on agar.

Brotb: Slightly turbid with slight, grayish sediment.

Litmus milk: Unchanged.

Potato: Slight, creamy-white, smooth. entire growth.

Indole not formed.

Nitrites produced from nitrates.

No acid from carbohydrate media.

Hydrolyzes urea (Merkel, Cent. f. Bakt., I Abt., Orig., 147, 1941, 398).

Aerobic, facultative.

Optimum temperature 37°C.

Not pathogenic.

Source: From oral cavity of 26 out of 45 control cases.

Habitat: Normal throats.

 Corynehacterium enzymicum (Mellon) Eberson. (An unusual diphtheroid bacillus, Mcllon, Mcd. Record, New York, 81, 1916, 210; Bacillus enzymicus Mollon, Jour Bact., 2, 1917, 297; Eherson, Jour. Inf. Dis., 25, 1918, 29.) From Greek en, inside of; syme, leaven; of an enzyme. Rods, beaded and club-shaped, defi-

nitely pleomorphic, showing coccoid forms. Non-motile. Gram-positive.

Gelatin stab Slight surface growth. No liquefaction.

Glucose agar: Bacillary form shows very small colorless colonies. Coccoid form shows heavy, yellowish-white, moist growths.

Blood agar : Same as on glucose agar.

Loeffler's blood serum: Fine, moist, confluent growth.

Glucose broth: Bacillary form shows granular sediment Coccoid form shows diffuse, luxuriant growth.

Litmus milk: Acid, coagulated.

Potato: No growth

Indole formation slight.

Slight production of nitrites from nitrates.

Acid from glucose, maltose, sucrose. dextrin and giveerol.

Aerobic, facultative.

Optimum temperature 37°C.

Pathogenic for rabbits, guinea pigs and mice.

Source: Lungs, blood and joints. Habitat : From human sources so far as known.

4. Corynebacterium zerose (Neisser and Kuschbert) Lehmann and Neumann. (Bacillus zerosis Neisser and Kuschbert, Breslauer ärtzl. Ztschr., No. 4, Xerosebacillen, Kuschbert, Deutsche med. Wochnschr., 10, 1884, 321 and 341: Pacinia neisseri Trevissa, I generi e le specie delle Batteriacee, 1889, 23, Lehmann and Neumann, Bakt Ding., 2 Aufl., 2, 1899, 405; Bacterium xerosis Migula, Syst. d. Bakt., 2, 1900, 485.) From Greck zerus, dry.

An excellent historical discussion of this organism is given by Andrewes et al, Diphtheria, London, 1923, 377-382.

Rods, showing polar staining, occasionally club-shaped forms are seen. Non-motile. Gram-positive.

Plain gelatin colonies: Rarely develop. Serum gelatin stah: No liquefaction. Agar eolonies: Minute, circular, almost transparent, raised, smooth, pearly white.

Agar slant: Thin, grayish, limited

growth. Loeffler's blood serum: Thin, grayish,

adherent growth. Broth: Clear, with slight, granular sediment.

Litmus milk: Unchanged.

Potato: No visible growth.

Indole not formed.

Nitrites not produced from nitrates. Acid from glucose, fructose, galactose,

maltose and sucrose.

Not pathogenic.

Aerobic, facultative. Optimum 'temperature 37°C. Grows very slowly as lowas 18° to 25°C (Eberson,

Jour. Inf. Dis., 23, 1918, 3). Source: From normal and diseased con-

iunctiva.

Habitat: Probably identical with other species described from the skin and other parts of the body.

Corynebacterium hoagii (Morse) Eberson. (Bacillus X, Hoag, Boston Med. and Surg. Jour., 157, 1907, 10; Bacillus hoagii Morse, Jour. Inf Dis. 11, 1912, 284; Eberson, Jour Inf. Dis. 23, 1918, 10.) Named for Hoag, the bacteriologist who first isolated the species.

Rods: 08 to I.0 by I.0 to 30 mierons, occurring singly. Show polar staining in the shorter forms while the longer forms are barred and slightly club-shaped.

Non-motile. Gram-positive. Gelatin colonies : Small, dull, pale pink,

entire. Gelatin stab. Slight pink surface

growth. No liquefaction. Agar colonies: Small, pale pink, dull,

granular, ontire. Agar slant : Filiform, dull, pink growth Broth: Turbid, with slight pink sedi-

ment. Litmus milk: Slightly alkaline, with

pink sediment.

Potato: Dull, filiform streak

Indole not formed.

Natrites not produced from nitrates Acid from glucose and sucrose but not

maltose. Blood scrum: Dull, filiform, pink

strenk.

Aerobic.

Outimum temperature 30°C.

Source: From the throat. Air contamination of cultures.

Habitat: Unknown.

6. Corynebacterium acnes (Gilchrist) Derson. (Bacillus acnes Gilebrist, Johns Hopkins Hosp, Repts, 9, 1901, 425, Actinomyces acres Gilchrist, ibid , 425; Eberson, Jour. Inf. Dis , 23, 1918, 10, Fusiformis acnes Holland, Jour Bact., 5, 1920, 233; Propionibaelerium acnes Douglas and Gunter, Jour Bact , 52, 1916, 22) From M L. acne, the discase nene.

Rods, vary in dimensions, usually 05 by 0.5 to 2.0 microns, sometimes slightly club shaped. Show alternate tunds of stained and unstained material Nonmotile. Gram-positive.

Growth in culture media very feeble. Best growth occurs in shake cultures with soft, slightly acid, glucose agar.

Agar alant. Very small, circular transparent colonies which may later become rose-colored.

Loeffler's blood serum: Small, grayish colonies, which may later become rosecolored.

Broth: Clear

Litmus milk: Soft coagulum.

Patato · Na growth in aerobic cultures. but pink streak in anaerobie cultures.

Indole not formed.

Nitrites produced from nitrates. Acid from glucose, sucrose (slight), maltose, mannitol and mulin Produces propionse acid (Douglas and Gunter,

loc cit) Catalase produced

Microscropbilic to anaerobic.

Optimum temperature 35° to 37°C. Pathogenic for mice and gives rise to

characteristic lesions.

Source: From acne pustules

Habitat: Sebaccous glands, hair follieles and aene pustules.

Notes. Even before 1901, several authors reported finding bacteria in aene pustules which were evidently diphthorold in nature. Unna (Monatshefte f. prakt. Derm , 15, 1801, 232) found an organism in aeno pustules which be gavo the name of Flaschenbacillus. Hodara (Monatshefte f. prakt. Derm , 18, ISO1, 586) reported the presence of two types of bacteria in acne lesions, the second of which he called Flaschenkugelbacillus. Sabouraud (Ann Inst Past, 11, 1897, 131) gave a more accurate description of these diphtheroids which he reported to need an acid medium for growth. He enlied this bacterium, bucille de séborthie grasse (Bacillus sabouraud: Neveu-Lemaire, Précis Parasitol Hum 5th ed., 1921, 21).

Additional anaerobic species will be found in the appendix. These are Corunebacterium tuphi which Liberson (loc.cit. 19) and Hewlett (Med Res. Council, Syst. of Bact , London, 5, 1930, 145) regard as practically identical with Corynebacterium acnes, and eleven species listed by Prévot (Manual de Classification et de Détermination des Bactéries Anaérobies. Monographie, Inst. Past., Paris, 1940, 199-204) as follows: Corynchacterum diphtheroides, C avidum, C. renale cuniculi, C. lymphophilum, C. hepatodystrophicans, C. parum, C. anaerobium, C. granulosum, C. adamsoni, C luquefaciens, and C pyogenes bouts.

7. Corynebacterium pyogenes (Glage) Eberson, (Bacillus liquefaciens pyogenes boris Lucet, Ann. Inst. Past. 7, 1893, 327; Bacillus liquefaciens progenes Lucet, ibid., 327, Bacillus liquefaciens Lucet, ibid, Bakterium der multipler Abszessbildung der Schweine, Grips, Ztschr f Fleisch- u Milehhvg., 8, 1898. 166; Bacillus pyogenes boris Kunnemann. Arch. f. wiss u prakt Tierheilk., 29, 1903, 128, Bacillus pyogenes Glage, Ztschr. f Fleisch- u Milchhyg, 18, 1903, 166, not Bacillus pyogenes Lucct, Ann. Inst. Past , 7, 1893, 327, Bacillus pyogenes suis Lehmann and Neumann, Bakt. Diag , 4 Aufl , 2, 1907, 394, Bacterium hyopyogenes Lehmann and Neumann, Bakt. Diag , 4 Aufl , 2, 1907, 394; Bacterium pyogenes suis Lehmann and Neumann. Bakt Diag , 7 Aufl , 2, 1927, 499; Bacterium pyogenes Ward, Jour Bact . 2. 1917, 519, not Bacterium pyogenes Chester, Man Determ Bact, 1901, 184; Eberson, Jour Inf Dis , 23, 1918, 5; not Corynebactersum pyogenes Lewandowsky, Cent. f Bakt, I Abt, Orig, 86, 1904, 473; Corynebacterium pseudopuogenes Ochi and Zaizen, Jour Jap Soc Vet Sci, 15, 1936, 12 and 16. 1937, 8) From Greek pyum, pus: gignomai, producing

For description see Brown and Orcutt, Jour. Exp. Med., 32, 1920, 244.

Rods: 0 2 by 0 3 to 2 microns in length Smallest forms appear as scarcely visible points (coimnon in old absecses). Chains formed Club forms may be present Non-motile Gram-positive. Serum gelatur: Luquefaction

No growth on ordinary agar.

Scrum agar: Minute colonies after 36

to 48 hours. Surface colonies may increase to 3 mm in diameter. Colonies smoky brown by transmitted light and bluish-white by reflected light.

Bovine blood serum slants: Pit-like or more general areas of liquefaction. Serum bouillon: Cloudy with fine floc-

Serum bouillon: Cloudy with ine forculent grayish flakes that form a sediment like a streptococcus culture.

Milk: Congulation after 48 hours at 37°C, with acid at bottom of tube Separation of whey and peptonization.

Nitrites not produced from nitrates (Merchant, Jour. Bact., 50, 1935, 108).

Indole not formed.

Acid formed in serum bouillon from glucose, sucrose, lactose, and xylose but not from raffinose, inulin, mannitol and salicin.

Beta hemolytic, not hemoglobinophilic though growth is favored by proteins as egg albumen, scrum or blood (Brown and Orcutt, loc. cil.).

Optimum temperature 37°C. Growth range 20° to 40°C.

Intravenous injection of rabbits fatal.

Aerobic as well as anaerobic growth

Source: From bovine pus

Habitat: Found in abscesses in cattle, swine and other domestic animals.

8. Corynebacterium renale (Migul)
Ernst. (Bacillus renalis borts Boltinger,
in Enderlen, Zeit. f. Tiermed, 17, 1890,
346; Bacillus pythonephritir boum (is)
Hofflieh, Monatsh. f. prakt. Tierbeilk. f.
1891, 356; Bacterium renale Migulo,
Syst. d. Bakt., 2, 1900, 504; Bacillus
renalis Ernst, Cent. f. Bakt., 1 Abt.,
Orig., 39, 1905, 550; Ernst, 1614, 49, 180;
Gorynebacterium renalis borts Irnst,
biid., 82.) From Latin renalis, kidner,

to the control of the

Description largely taken from Jones and Little, Jour. Exp. Med., 44, 1926, 11.

Rods: 0.7 by 2 to 3 microns. Normotile Usually in masses, rarely stepf-Bacteria from tissues not as pleasmplic as those from the earlier transfer cultures although many show polar grander or assollen ends. Cultures grown in both show coccoid forms and beaded rols with swollen ends. Gram-positive.

Gelatin: Grows poorly if at all. No liquefaction.

Agar: Small punctiform colonies

Agar slants: Raised, grayish-white, and dry growth (Jones and Little) Others say cream-colored and moist

Blood scrum slants · Fine gray punetiform colonies in 24 hours at 37°C which are a little larger than on agar Streak scarcely 1 mm in width Glistening and slimy in fresh cultures No Inquefaction.

Litmus milk: Reduction and coagulation from the bottom Slow digestion, becoming alkaline.

Broth: Sediment at end of 2 days with clear boullon above.

Potato: Growth grayish-white, later, becoming a dingy yellow, turning the potato brown

Acid from glucose No acid from lactose, sucrose, maltose and mannital Some strains ferment fructose and mannose (Merchant, Jour Bact, 39, 1937, 100).

Shows a close serological relationship with Corynebacterium pseudotuberculosis (Merchant). Anaerobje.

Not pathogenic for laboratory animals

No toxin produced Optimum temperature 37°C.

horses and dogs

Source Found in pyclonephritis in

cattle
Habitat: Occurs in purulent infections
of the urinary tract in cattle, sheep,

9. Corynebacterium pseudotubereniosis (Buchanan) Eberson (Nocard, Bull
de la Soc Cent de méd Ver, 1885, 207.
Pseudotuberculose-Bakterien, Press,
Cent. f Bakt., 19, 1891, 595; Bacellus pseudotuberculosis enis Lehmann and Neumann, Bakt. Diag., 1 Aud., 2, 1896, 362;
Bacillus pseudotuberculosis Buchanan,
Veter. Bact., Phila., 1911, 233; sot
Bacillus pseudotuberculosis Eigenberg.
Bakt. Diag., 3 Aufl., 1891, 291; Eberson,
Jour. Inf. Dis., 25, 1918, 10; Corynebecterium oris Bergey et al., Manual, 1st
et., 1923, 385; not Corynebecterium presu-

dauberculosis Bergey et al , Manual, 2nd ed. 1925, 394, Corynebacterium pseudotuberculosis boris (an evident typographieal error) Thomson and Thomson, Ann. Prekett-Thomson Res. Lab. 2, 1926, 132; Corynebacterium pseudotuberculosis oris Hauduroy et al , Dict. d Bact Fath., 1987, 159; Corynebacterium presis-necardi Hauduroy et al., ioid , 159) From Greek pseudus, a falsehood; Latin luberculum, a gmall module, M. L., false tuberculosis.

Common name Preisz-Nocard bacillus Slender rods: 0.5 to 0.6 by 1.0 to 3.0 microns, staining irregularly and showing clubbed forms. Non-motile, Grampositive

Gelatin colonies. Slight development Gelatin stab: No liquefaction.

Agar colonies. Thin, cream-colored to orange, folded, serrate, dry

Loeffler's blood serum Small, yellow, retrate colonies No liquefaction Broth: No turbudity, Granular sadi-

Broth: No turbidity. Granular sedinient. Pellicle formed (Carne, Jour. Path and Boet., 49, 1939, 316)

Letmus milk Unchanged Potato: No growth

Netrates not produced from nitrates.

Acid from glucose, fructose, galactose, mannose, eucrose, lactose, maitose and devtrin. Some strains attack xylose. Causes caseous lymphadenitis in sheep

and ulcerative lymphangitis in horses.
Forms an evotovin
Shons a close serological relationship

Shows a close serological relationship with Corynebacterium renale (Merchant, Jour. Bact, 30, 1935, 109)

Acrobic, facultative Optimum temperature 37°C.

Source. From necrotic areas in the

Habitat Found in cascous lymphadenits in sheep and ulcerative lesions in horses, cattle and other animals

10 Corynebacterium kutscher! (Migula) Bergey et al. (Bacillus pseudotuberculosis murium Kutscher, Issehf. Hyg., 18, 1891, 338; Bacillus pseudotuberculosis murium Lehmann and Keumann, Bakt. Diag., 1 Aufl., 2, 1896, 362; Bacterium kutscheri Migula, Syst. d. Bakt., 2,, 1900, 372; Mycobacterium pseudotuberculosis Chester, Manual Determ. Bact., 1901, 355; Corynebacterium murium Bergey et al., Manual, 1st ed., 1923, 385; Bergey et al., Manual, 2nd ed., 1925, 395.) Named for the bacteriologist Kutscher, who first isolated the species.

Rods with pointed ends, staining irregularly. Non-motile. Gram-positive.

Celatin colonies: Small, white, translucent.

Gelatin stab. No growth on surface. White, filiform growth in stab. No liquefaction.

Agar colonies: Small, thin, yellowishwhite, translucent, serrate.

Agar slant: Thin, white, translucent Loesser's blood serum: Abundant

growth. Not peptonized. Broth: Slight turbidity. Crystsls of ammonium magnesium phosphate are

formed. Litmus milk Unchanged.

Potato: No growth.

Indole not formed. Nitrites not produced from nitrates

Aerobic, facultative.

Optimum temperature 37°C.

Source: From cheesy mass in luog of mouse.

11. Corynebacterium murlsepticum v. Holzhausen. (Cent. f. Bakt., I Abt., Orig., 105, 1927-28, 94.) From Latin mus, murs, a mouse; Greek septicus, putrefying, septic.

Slender rods: 1.2 to 1.5 microns in length, with polar granules. Grow out into long filaments. Non-metile. Gram-Dositive.

Gelatin stab: Feeble growth, with fimbriate outgrowth slong line of puncture.

Egg glycerol broth Good growth.

Locffler's blood serum: Good growth.

Broth: Turbid. Litmus milk: Acid. No congulation.

Potato: Good growtb.

Indole not formed.

Nitrates not reported.

Acid from glucose, fructose, galactose, maltose, lactose, sucrose, inulin and mannitol. Ambinose and isodulcitol are not attacked.

Hydrogen sulfide formed. Pathogenic for mice. Aerobic, facultative.

Optimum temperature 37°C. Habitat: Septicemia in mice.

12. Corynebacterium bovis Bergey et al. (B. pseudodiphtheria, Bergey, The Source and Nature of Bacteria in Milk Penn. Dept. Agr. Bull. 125, 1904, 11; Bergey et al., Manual, 1st ed., 1922, 83) From Latin bos, bovis, ox; of cattle.

Rods, slender, barred, clubbed, 0.5 to 0.7 by 2.5 to 3.0 microns. Non-motile Gram-positive.

Gelatin stab: Slight, gray, flat surface growth.

Agar colonies: Circular, gray, slightly raised, radiate, undulate, dry.

Agar slant: Thin, gray, filiform, dry growth.

Broth: Slight granular sediment. Litmus milk: Slowly becoming deeply nlkaline.

Potato: No growth.

Indolo not formed.
Nitrites not produced from nitrates

No acid from carbohydrate media.

Blood scrum: Thin, gray, filiform
growth.

Causes rancidity in cream. Wesly lipelytic on tributyrin agar (Black, Jour Bact., 41, 1941, 99).

Optimum temperature 37°C.

Source: In fresh milk drawn directly from the cow's udder.

Note: Miss Alice Evans (personal communication) states that the organiza from the udder which she described at Bacterium lipolyticus (sic.) (Bacillar abortus var. lipolyticus Evans, Jou-Inf. Dia., 18, 1916, 459; Bacterium abortus var. lipolyticus Evans, Jour. Bact., f. 1917, 185; Evans, Jour. Inf. Dis., 22, 1918, 576; not Bacterium lipolyticum Huss. Cent. f. Bakt., II Abt., 20, 1908, 474; Alcaligenes lipolyticus Pacheco, Revista da Sociedade Paulista de Med. Vet., 5. 1933. 9) was probably a Corunebactersum This is also regarded as probable by Steck (Die latente Infektion der Milchdruse, Hanover, 1930) and by Bendixen (Ztschr. f. Infektionskrankh. d Haustier., 45, 1933, 106). Miss Evans also indicates that it is probable that the organism described by Bergey first in 1904 (loc. cit.) and later in the first edition of the Manual as Corynebastersum bovis was the same organism. This is further confirmed by Black (Jour Bact, 41, 1941, 99). A description of Bacterium lipolyticum Evans will be found in the Manual, 5th ed , 1939, 803

13. Coryaebscterium equi Magnussen (Alagnussen, Arch f Terheik. 20, 22; Coryaebacterium pyogenes (equi Meissner and Wetzel, Deutsche Tierarti. Wehnsehr, 31, 1923, 419, Corynebacterium (pyogenes) equi roseum Luij., 1611, 361; Mycobacterium equi Jensen, Proc. Lian. Soc. New So. Wales, 39, 1934, 33; Corynebacterium magnusson-holth Plum, Cornell Vet., 30, 1910, 15; Corynebacterium purulentus Holiman, Jour. Bact., 49, 1945, 161.) From Latin equus, bores.

Description from Dimock and Edwards, Kentucky Agri. Exper Stat, Bull. 333, 1932; Bruner and Edwards, ibid., Bull. 414, 1941; Merchant, Jour Bact., 30, 1935, 95; and Brooks and Hucker, Jour. Bact., 48, 1944, 309.

Rods variable according to medium Coccoid and ellipsoidal cells to rather long curved and sometimes clubbed forms. The latter are especially apt to occur in liquid media. Non-motile Gram-positive

Gelatin stab : Good growth. No lique-

Agar colonies: Usually moist, smooth and glistening, tan to yellow (Brooks

and Hucker, loc. cit., p. 300) or pink to red chromogenesis (Merchant, loc. cit., p. 107).

Agar alant: Moist heavy growth which may run down the slant (Dimock and Edwards, loc. cit, p. 322).

Broth: Turbid with no pellicle and little sediment (Dimock and Edwards, loc. cit., p. 322). Pellicle and final pH alkaline (Brooks and Hucker, loc. cit., p. 309). Branched cells occur in 6 to 8 hour cultures in broth.

Loeffler'a blood serum: Good growth with tan to yellow chromogenesis No liquefaction,

Coagulated egg yolk: Vigorous salmonpink growth Dryer than on agar, resembling wrinkled growth of tubercle baullus after two weeks.

Litmus milk: No change to slightly alkaline.

Potato · Abundant growth, usually tan, yellow or pink

Indole not formed

Hydrogen sulfide produced on appropriate media.

Nitrites produced from nitrates No ammonia produced.

No acid from carbohydrate media However, glucose stimulates growth. Sodium hippurate: Not hydrolyzed.

Sodium hippurate: Not hydrolyzed. Esculin: Not hydrolyzed.

No evotoxin demonstrated in filtrate of broth cultures

No or alight hemolysis of horse blood. Not pathogenic for laboratory animals. Aerobic.

Temperature relations: Optimum 25° to 37°C. Maximum 37° to 45°C. Minimum 7° to 18°C.

Source Originally isolated from infectious pneumonia of foals.

Habitat Found in spontaneous pneumonia of feals and other infections in horses Also in swine, cattle and buffaloes

Nore: Jenson (loc cit., 33) regards four cultures of soil bacteria isolated in Australia as identical with this organism. Because of the acid-fast staining of the cells, especially when grown in milk for 3 to 7 days, he places this species in the genus Mucobacterium. Most cocci retain the stain completely, while the rods take the counterstain. Jensen thinks the organism a widespread soil saprophyte which under certain conditions acquires pathogenic properties. He points out the close relationship of this organism to Bacterium aurantium-roscum (Mededeel, Deli Proefstat te Medan, 7, 1912, 223) isolated from fermenting tobacco. He also regards this species as closely related to Mycobacterium coclageum Gray and Thornton. Red strains seem to be much like Bacillus rubrovertinctus Hefferan and Micrococcus (Staphylococcus) crythromyxa Zont.

14. Corynebacterium paurometabolum Steinhaus (Jour. Bact., 41, 1941, 763 and 783.) From Greek paurus. little, metabole, change or little action.

Rods: 0.5 to 08 by 10 to 25 microns. occurring singly, in pairs and in masses Metachromatic granules present Nonmotile Gram-positive.

Gelatin stab. Slow houefaction at sur-

Agar colonies White to gray, entire, circular, small, dry, somewhat granular. Agar slant. Filiform to arborescent, thick, granular growth.

Broth Abundant granular sediment but no turbidity. Pelliele

Litmus milk: Alkaline

Potato . Thick, raised, dry, granular, profuse, gray to light cream-colored growth

Indole not produced.

Slight production of hydrogen sulfide. Nitrites not produced from nitrates.

No action on the following carbohydrates: Glucose, lactose, sucrose, maltose, fructose, mannitol, galactose, arabinose, xylose, dextrin, salicin, raffinose, trehalose, sorbitol, inulin, dulcitol, glycerol, rhamnose, adouitol, mannose, escula and inositol.

Aerobic.

Slight alpha hemolysis.

Non-pathogenic for guinea pigs.

A special semi-solid medium, the main nutritive constituents of which were proteose peptone, rabbit serum, gelatus, minced rabbit kidney and carbohydrates, was used for the original isolation An incubation period of 4 to 7 days at 26°C was necessary for the initial isolation. Subsequent transfers to ordinary beefinfusion agar grew out in 24 to 48 hours

Source: From media inoculated with the mycetome and ovaries of the bedbug Cimex lectularius L. A very similar diphtheroid strain was isolated from the alimentary tract of the bagworm, Thyridopteryz ephemeraeformia Haw.

Habitat: Distribution in nature unknown.

\*15. Corynebacterium insidiosum (Mc-Culloch) Jensen. (Aplanobacter int diosum McCuiloch, Phytopath., 15, 192 497; Bacterium insidiosum Stapp, 1 Sorauer, Handb. der Pflanzenkr., 2, Aufl., 1928, 178; Phytomonas insidios Bergey et al., Manual, 3rd ed , 1930, 278 Jensen, Proc. Linucan Soc. of New & Wales, 59, 1934, 41.) From Latin # sidiosus, deceitful, dangerous.

Also see McCulloch, Jour. Agr. Res \$5, 1926, 502,

Rods: 0.4 to 0.5 by 0.7 to 1.0 micron Capsules present. Non-motile Gram positive.

Gelatin: Slow liquefaction.

Beef agar colonies: Pale yellow, circu lar, smooth, shining; edges entire; viscid Blue granules found on the medium

Milk Congulated after 16 to 20 days No digestion. An apricot yellow sedi ment is deposited on the walls of the tube.

<sup>\*</sup> Descriptions of Species nos 15 to 20 inclusive prepared by Professor Walter II Burkholder, Ithaca, New York.

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Diseases, 1913, 30; Aplanobacter michiganense Erw. Smith, Bacteria in Rel. to
Plant Dis., 3, 1914, 161; Phytomonas
michiganensis Bergey et al., Manual,
ste d., 1923, 101; Jensen, Proc. Linnean
Soc. of New So. Wales, 59, 1934, 47;
Erwinia michiganeae, incorrectly attributed to Bergey by Jensen, Joc. cit.,
47.) Latinized, of Michigan, where the
disease produced by this patbogen was
first reported.

Description from Bryan, Jour. Agr. Res., 41, 1930, 825.

Rods: 0.6 to 0.7 by 0.7 to 1.2 microns. Non-motile. Capsules. Gram-positive. Characteristic angular growth with branching and club-shaped cells (Jensen, loc. cit.).

Beef agar colonies: Growth slow, mustard yellow, smooth, glistening, butyrous.

Chromogenesis. Develops yellowishbrown, light ochre-yellow to sopia brown colors on suitable media (Jensen, loc cit.).

Gelatin Slow liquefaction

Broth Turbidity slow and moderate. Milk. Slow coagulation. No peptonization.

Nitrites not produced from nitrates. Utilizes peptone, but not ammonia, nitrite, nitrate, tyrosine, asparagine or

nitrite, nitrate, tyrosine, asparagine or glutamic acid (Musbin, Austral. Jour. Exp. Biol and Med., 16, 1938, 326). Indole not produced

No H<sub>2</sub>S produced.

Acid from glucose, sucrose, galactose, fructose, maltose, and slight acid from lactose, glycerol and mannitol.

Starch: Very weak diastatic action. No growth in 3 per cent salt

No growth in 3 per cent salt Optimum temperature 25° to 27°C Maximum, 33°C Minimum, 1°C

Aerobic.

Source: From the bacterial canker of tomato.

Habitat : Pathogenic on tomato

17a. Corynebacterium michiganense var. saprophyticum Jensen (loc. cit., 48). Grows more rapidly and with more moist growth, has a higher temperature manmum and stronger proteolytic activity than the pathogenic strains. From grass soil in Australia.

18. Corynebacterium rathayi (Err. Smith) Dowson (Aplanobacter 12 thayi Erw. Smith, Science, 38, 1913, 39, and Bact. in Rel. to Plant Dis., 5, 1914, 155; Phylomonas rathayi Bergey et al., Manual, 1st ed., 1923, 192; Bacterium rathayi Stevens, Fungus Dis. of Plant, 1925, 22; Dowson, Brit. Myo. Soc. Trans. 25, 1942, 313.) Named for E. Rathay, the Austrian plant pathologist who first isolated the species.

Rods: 0.6 to 0.75 by 0.75 to 1.5 merons Non-motile. Not acid-fast. Capsules Gram-positive.

Gelatin: Slow liquefaction after 7

Agar colonies: Small, yellow, slow growing.

Milk: Growth slow. Yellow ring Litmus milk: Alkalino and reduced. Natrites are produced from nitrates Potato plugs: Good, yellow, visual growth.

Acid but no gas from glucose, sucrose and lactose.

Cohn's solution: No growth.

Heavy inoculum necessary in medis.
Source: Isolated from slimy heads of
Dactylis glomerata by E. Rathay in
Austria.

Habitat: Pathogenic on Dactylis clo-

merala.

Norn: Bacillus mucilaginosus koderica Aujessky, Botanikai Koslemenych, 13, (Foreign Supl. 41), 1914, 83; Prubmonas mucilaginosus holerica Most. Schodis ad Flora Hungarica Exs. Cesl. IV, No. 301, Sect. Bot. Mus. Nat. Husg. Budapest, 1915. The description of the bacterium is possibly that of the sprephyte, Pseudomonus fuorescens, but description of the disease is that caused by Corynabacterium rathayi. The spreimen in schedis is a head of grain test appears to be infected with Corynabacterium the section of the disease of the spread of the spread of the disease is that caused by Corynabacterium rathayi.

terium rathayi.

19. Corynebacterium egropyri (O'Cara). comb. nos. (Aplanobacter agropyri O'Cara). Phy topath, 6, 1916, 343; Phytomonas agropyri Bergey et al., Manual, ist ed., 1923, 190; Bacterium agropyri Stapp, in Somuer, Handbuch d. Pflanzenkrankheiten, 5 Aufl., 2, 1923, 37.) From Greek agros, field and puros, wheat; M. L. Agropyron, wheat grass.

Rods: 0.4 to 0.6 by 0.6 to 1.1 microns Capsules. Non-motile. Gram-variable Gelatin: No liquefaction

Nutrient agar slant: Meager, yellow, very viseld growth.

Broth: Light clouding with yellow pre-

Milk: Little changed Yellow seds-

ment formed.

Nitrites are produced from nitrates Acid but no gas from glucose, lactose, sucrose and glycerol.

Starch: Hydrolysis feeble

Optimum temperature 25° to 25°C
This speeles is very similar to and may

be identical with Corynebacterium rathays Dowson,

Source: From alimy heads of wheat grass.

Habitat: Found on wheat grass, Agropyron smithii.

20. Corpuebacterium fascians (Til ford) Dowson, (Phytomonas fascians Tilford, 54th Rept. Ohio Agr Lvp Sta Bull. 561, 1936, 39; Jour. Agr Res , 55, 1936, 393; Umanned pathogen, Lacey, Ann. Appl Biol., 25, 1936, 308, Dowson, Brit. Myc. Soc. Trans, 25, 1922, 313 From Latin fascio, producing a fasciation Rodz; 0,5 to 0 9 br 1 St 0 4 0 micross

Non motile. Gram-positive

Gelatin · No liquefaction

Putato glucose agar colonies Light cream-colored colonies appear after 72 hours l'unetiform, circular, later cadmium sellow to deep chrome

Nutrient sgar stant. After one week streak is fillform, flat, dull to glistening, arreath, opaque, cream-colored, and butyrous Broth: Slightly turbid Fragile pel-

Milk: Litmus becomes blue Other changes slight.

Nitrites are produced from mitrates Indole not formed.

Hydrogen sulfide is produced.

Acid but no gra from glucose, gralactose, fructose, mannose, ambinose, xylose, maltose, sucrose, glycerol, mannitol and dextrin No neid from rhamnose, lactose, raffinose and inulia.

Starch not hydrolyzed
Gross in 8 per cent salt

Optimum temperature 25° to 28°G

Aerobic

Bouree: Described from 15 single cell isolates from fasciated growths on sweet ness.

Habitat. Pathogenic on sweet pea, chrysanthemum, geranium, petunia, tobacco, etc

21 Corynebaterium helvolum (Zimmerman) Kaskalt and Berond (Baeilias kelcolus Zimmermann, Bekt unerer Trink- u. Nutrwisser, Chemmitz, I, 1520, 22, Bacterium kelcolum Lehnann and Neumann, Bakt Dag, 1 Aufl, 2, 1896, 23, Kaskalt and Berend, Cent f Bakt, 1 Abt, Orig., 81, 1915, 446, Flatiobacterium kelcolum Bergey et al. Manual, list ed., 1923, 114) From Latin keltur, of a helit bay column.

Original description supplemented from Jensen, Proc Lann See New So. Wales, 52, 1931, 37

Rods 0.5 by 10 micron, occurring singly. Show argular arrangement due to snapping division. Variable in neuphology. Non-motile. Gram-positive.

Gelatin colonies Small, circular, yellowish gray Liquefaction Gelatin atab: Sight development along

Gelatin atab: Sight development along the atab Napilorm inquelection Agar colonies Circular, pale yellow,

emonth, slightly contex.

Agar slant: Pale yellow, plumose to

spreading, meist, undulate.
Milk agur: Growth fair to very abun-

dant, white to pale yellow. Some strains form a pink pigment. Protectvtic zones clear and broad after 4 days.

Asparagine agar: Seant to good growth, smooth, glistening, white and creamcolored to lemon-vellow or even dull nink.

Broth: Turbid, with gray ring and vellowish sediment. After four days the sediment contains long, curved and branching rods. May resemble small mycelia.

Litmus milk: Slightly acid, with soft coagulum, becoming alkaline; peptonized. Litmus reduced.

Potato Pale yellow, moist, plumose growth, becoming rough, dull, Slimy variants noted in one strain. A myceloid variant with dry wrinkled growth was found in another strain.

Indole not formed.

Nitrites not produced from nitrates.

Acid from glucose, glycerol and mannitol. Usually from arabinose, sucrose, galactose, fructose,

Aerobie, facultative.

Hydrogen sulfide produced on appropriate media

Optimum temperature 25°C. Usually grous at 37°C.

Source Originally isolated from water. Habitat · A common soil Corunebacterium.

22. Corynebacterium fimi (McBeth and Scales) Jensen. (Bacterium fim: McBeth and Scales, Bur. of Plant Ind., U. S. Dept. Agr., Bull. 266, 1913, 30; Cellulomonas fimi Bergey et al , Manual, 1st ed., 1923, 166; Bacillus fim: Holland, Jour. Bact., 5, 1920, 218; Jensen, Proc. Linn, Soc New So. Wales, 59, 1934, 48.) From Latin fimus, dung

Description from Jensen (loc cit.) who

studied an authentic strain

Rods present typical diphtheroid appearance with angular arrangement, 04 to 0.5 by 1.2 to 2.5 microns. Many longer, tregular, curved, club-shaped and branching cells on Sabouraud's (whey) agar. Non-motile. Gram-negative (McBeth and Scales). Gram-variable like some other corynebacteria (Jensen).

Gelatin colonies; Small, round, becoming lobate. Slow liquefaction.

Gelatin stab: Granular yellow growth Infundibuliform liquefaction.

Cellulose agar colonies: Circular, raised, smooth, glistening, gray, entire

Agar slant : Smooth, glistening, white to lemon-vellow growth.

Glucose and Sabouraud's agar : Growth less abundant and cream-colored.

Asparagine agar: Very scant growth, narrow, thin, glistening, white.

Broth: Uniform turbidity, soft creamcolored to vellow sediment after 3 weeks Litmus milk: Coagulated at 3 weeks at

37°C. Not at 28° to 30°C. Faintly acid. Potato: Slow cream-colored to rellow

growth. Indole is formed.

Nitrites are produced from nitrates Ammonia is produced in peptone solu tions.

Diastatic action doubtful.

Acid from glucose, fructose, arabinese, xylose, maltose, lactose, sucrose, raffinese, melezitose, dextrin, starch, sahein and glycerol. None or feebly produced from mannitol and dulcitol.

Causes rapid disintegration of cellulose (filter paper) in a 0.5 per cent peptone

solution. Acrobic, facultative.

Optimum temperature 20°C (McBeth and Scales). Better growth at 37°C than at 25° to 30°C (Jensen).

Source: Probably isolated from soil Found in soils of Southern California (McBeth, Soil Sci., 1, 1916, 443).

Habitat : Soil.

Bacterium liquatum McBeth and Scales (McBeth and Scales, Bur. Plant Ind. U. S. Dept. Agr., Bull. 266, 1913, 32; . 1: ..... Rergey et al., Min anded

only

tween

the two species by the original was that Bacterium liquatum produced s yellow chromogenesis more readily This, however, does not appear to have occurred any more frequently than took place with the authentic culture of Bacterium fimi when tested by Jensen (foc cit.).

23. Corynebacterium tumestens Jen sen. (Jensen, Proc. Linn Soc New So Wales, 59, 1931, 45.) From Latin tumescens, swollen.

Rods show characteristic extensorphosis in glucose agar, Sabouraud's (when) agar and milk agar. Cells after 15 to 21 hours at 28° to 30°C are curved, often branched, show an angular arrangement 0.5 to 0 8 by 2 5 to 6 0 microns to 3 days many spherical to club shaped cyatites (3 microns in diameter) arise as local swellings of the rolls. Staming in tensely at first, they gradually change into large, irregular, poorly stained glasst cells which show deeply staming belts and granules leregular less anollen deeply stained rods and small cocce (0 \$ to 0.5 micron) which resemble the gran ules in the exetites are also present These cocci are living cells. Non-motile Gram-matise.

Celatin colonies, Small, sprigue, sel

Milk ager; Cystites develop in almost pure culture. These sometimes have 2 to 4 small ever intached to the wall so that they look like hushing yeasts. When trunsferred to fresh ager, systies either fail to grow or germinate with 2 to 4 slender penn tules which regenerate the role. Cystites ago are the produced more and the second of the control of t

37°C, sometimes not at all at 16° to 18°s. Sabournud's agar: Cystites sometimes 6 to 5 merons in demeter. Growth may be cream colored or even grayish past.

Asparagine agar Growth thin, fist, maint, colorless.

limith: Faint uniform turbidity, after 2 to 3 weeks, a soft white to eream colored seliment.

Milk: Thin white rice around surface Soft congulation after 18 to 29 days later, slow digestion. Faintly and Potato: Slow but eventually good growth, restricted, glistening, viscist, eream-colored to gravish-orange.

Acid from glucose, arabinose, galactese, maltose and glycerol; occasionally from sucrose and mannitol.

Nitrates produced from pitrates Optimum reaction pll 6.2 to 6.8.

Slimy variants produced after 172 days growth in lithium solution

Source: Two strains from grass soils and one from garden soil in Australia. Ifahitat Soil

21 Corynebacterium simplex Jensen. (Proc Lann. Soc New So Wales, 59, 1934, 43) From Latin simplex, simple.

Itods: 0.1 to 0.5 by 3.0 to 5.0 microns, curved and in parallel bundles Xo branching in older cultures but the cells grow shorter, becoming almost eneroid Angular arrangement Nonmontle Gram-rosuite.

Gelatin: Colonies very small Filiform growth along stab. Liquefaction after 4

Asparagine ager. Fair to good growth, becoming moist and glistening. No pla-

Glucese agar. Abundant grantli, Spreading, smooth, glustening, cream-colored to grayash-yellon.

Broth Uniform turbulity, grayish-

Milk Yellowish ring around surface No congulation Complete digestion after 10 to 12 days. Beaution routed

Natrates produced from natrates
Starch is not hydrolyzed

Acul from sucnee. Alkalite reschon in other sugar broths

Excellent growth at 37 'C'

Resembles Corpoductorism flameria, sum in cultural characters but does not form long Clarecots

Source. From grass rod and red roll from Griff the Australia

from Griff the Azetral Habitat & H.

25 Cotynebattetium filamertosom Jersen ihne lan ber New SoWales, 59, 1934, 42.) From Latin filamentosus, full of threads.

Rods: Variable in shape. Young cells typically curved, vibrio-like, 0.5 to 0.8 by 2.0 to 70 microns, sometimes longer and branched. Always in parallel bundles. Usually non-motile hut a few cells exhibit a peculiar oscillatory or rotatory movement Gram-positive.

Gelatin: Colonies small, spherical, entire. Filiform white growth in stab. Liquefaction slow starting at end of 7 days.

Asparagine agar: Good characteristic growth, widely spreading, central part convex, smooth, glistening, white, sending dendritic projections into the broad marginal part. Usually produces light greenish-yellow soluble pigment.

Glucose agar: Growth less vicorous than on asparagino agar, flat, creamcolored to grayish-yellow, viscid.

Sabouraud (whey) agar: Similar to glucose agar.

Potato · Scant to no growth, flat, glistening, cream-colored to gravish-vellow, surrounded by a white halo.

Broth · Paint uniform turbidity. Soft. flaky, cream-colored sediment.

Milk: White to cream-colored surface ring and sediment. No coagulation. Digestion in 2 to 4 weeks. Neutral to faintly acid

May produce nitrites from nitrates.

Starch is not hydrolyzed.

Acid from elycerol and arabinose. Strong and rapid alkaline formation in other sugar media

Optimum reaction pH 5.4 to 5.5.

Excellent growth at 37°C.

Aerobie.

Regarded as being much like Vibrio lingualis Eisenberg and Bacterium racemosum Zettnow.

Source: From red soil from Griffith, Australia.

Habitat : Soil.

Appendix I:\* The following four species of plant pathogens have an unusual combination of characters in that they are reported to he Gram-positive and polar flagellate. Cultures of two of the four species have been available for study and these and other characters have been rechecked by several persons. Corynebacterium flaccumfactens shows many wedgeshaped cells and longer cells with a slight curve. It is motile with a single polar flagellum and shows Gram-positive with commonly used procedures for Gram-staining. Corynebacterium poinsettiae shows a straighter form of cell but in other characters is like C. flaccum. faciens. Prof. W. H. Burkholder and Dr. M. P. Starr really feel that these organisms are most closely related to other more typical corynebacteria They are therefore placed for the present in this appendix, although by the characters used in the keys they would be placed in Pseudomonadaceae.

 Corynebacterium hypertrophicans (Stahel) comb. nov. (Pseudomonas hypertrophicans Stahel, Phyt. Ztschr., 6, 1933, 445; Phytomonas hypertrophicans Magrou, in Hauduroy et al., Dict. d Bact. Path., Paris, 1937, 367.) From Greek hyper-trophe, hypertrophy.

Rods: 0 6 to 0 8 by 1.2 to 28 microns Motile with a polar flagellum. Bipolar

staining. Gram positive.

Gelatin: No growth. Agar colonies: Slow growing, circular,

raised, wet-shining, white.

Broth plus sucrose: Growth good. No pellicle.

Milk: No visible change.

Nitrites not produced from nitrates Indole not formed.

No H.S produced.

Acid but no gas from glucose, fructose and sucrose. No acid from lactose and glycerol. The acids from sucrose are lactic and formic

Prepared by Prof. Walter H. Burkholder, New York State College of Agriculture, Ithaca, New York, May, 1945.

Aerobie.

Source: From witches' brooms. Habitat: Pathogenie on Eugenia lati-

folia.

Corvnebacterlum flaccumfactens (Hedges) Dowson. (Bacterium flaccumfaciens Medges, Science, 55, 1922, 433, Phytopath., 16, 1926, 20; Phytomonas flaccumfaciens Bergey et al., Manual, 1st ed., 1923, 178; Pseudomonas flaccumfacions Stevens, Plant Diseases of Fungi, 1925, 27; Dowson, Brit. Mye Soc Trans., 25, 1942, 313.) From Latin flaceus, flabby or wilted; facto, to make; producing a wilt.

Rods: 03 to 0.5 by 06 to 3 microns. Motilo with a single polar flagellum; also non-motile (Adams and Pugsley, Jour. Dept. Agr. Victoria . 32, 1934, 306) Grom-positive.

Gelatin . Liquefaction feeble.

Beef agar slants: Rather moderate growth, glistening, flat, smooth, viscid and yellow.

Broth: Moderate turbidity in 21 hours Pellielo formed.

Milk. Acid curd and slow peptonization.

Nitrites not produced from pitrates.

Indole not formed No ILS formed.

Acid from glucose, lactose, sucroso and glycerol.

Starch not hydrolyzed.

Slight growth in 5 per cent salt Optimum temperature, 31°C Maxi-

mum temperature 36° to 40°C. Distinctive character: A strict vascular

parasite of the bean. Source: From wilted bean plants from

South Dakota.

Habitat · Causes a wilt of beans and related plants.

3. Corynebacterium poinsettiae Starr and Pirone. (Phytopath , 52, 1912, 1080; Phytomonas poinsettiae, ibid.) From M. I., old genus Poinsettia.

Rods: Average cells 0.3 to 0.8 by 1.0 to 30 microns. Pleomorphic with some cells 8.5 microns in length. Granules and capsules present. Motile with I (rarely 2) polar or lateral flagellum. Gram positive.

Gelatin: Liquefaction.

Loeffler's blood-serum: Liquefaction. Beef-extract agar colonies: Round, slightly convex, 0.1 to 1.0 mm in di-

ameter, edges entire, smooth, non-viseid, coloriess and almost transparent. Potato glucose agar slants: Moderate

growth, filiform, glistening, non-viseid, salmon to flesh color. Beef-extract broth: Turbid in 24 hours,

abundant pale salmon sediment. No nelfiefe

Milk: Slight scidity but no other visible change for 2 weeks, then a soft curd, reduction of litmus, and complete pentonization.

Indole not produced

Netritea not produced from nitrotes. Hydrogen sulfide not formed.

Sodium hippurate not hydrolyzed. Asparagino not utilized as earbonnitrogen source. Uric acid not utilized:

urea not bydrolyzed

No lipolytic activity. Voges-Proskauer test negative. Methyl red test negative

Moderate to abundant acid, but no gas, from glucose, fructose, mannose, galactose, sucrose, maltose, cellobiose, melibiose, raffinose, glycerol, erythritol, salicin and amygdalin; neak acid from arabinose, xylose, lactose, trehalose, devtrin and adonitol; no acid from rhamnese, fucose, inulin, glycogen, mannitol, dulcitol, sorbitef and inositel.

Starch hydrolyzed.

No action on cellulose. Teflurite reduced.

Aerobie.

Growth occurs after 24 hours from 15°C to 36°C: after 43 hours from 7°C to 12°C. No growth above 36°C or below 7°C at the end of a week.

Source: Fourteen cultures isolated from diseased stems of pointettia. Euphorbia pulcherfima

Habitat: Causes a canker of stems and spots on leaves of the pointettia.

Corynebacterium tritici (Hutchinson) comb. nov. (Pseudomonas tritici Hutchinson, India Dept. of Agr., Bact. Ser. 1, 1917, 174; Phylomonas tritici Bergey et al., Manual, 3rd ed., 1930, 283, Bacterium tritici Elliott, Bacterial Plant Pathogens, 1930, 234.) From Latin triticum, wheat; M. L., from the genus Triticum.

Rods 0 8 by 2.4 to 3.2 microns. Motile with a polar flagellum. Gram-positive. Gelatin: No liquefaction.

Agar colonies Bright yellow becoming orange, glistening, moist, margins entire. Agar brownish

Broth Turbid. Thin pellicle.

Milk Yellow surface and yellow precipitate. Little change.

Nitrites produced from nitrates. No II<sub>2</sub>S produced.

Acid but no gas from glucose and lactose.

This species is very similar to and may be identical with Corynchacterium rathayi Dowson.

Source: From slimy heads of wheat in

Habitat: Pathogenic on wheat, Triti-

\* Appendix II: By the use of names or by the descriptions given, authors have indicated that the following are related to the species placed in Corynebacterium Many are incompletely described and may be identical with other recognized species

Bacillus alcalifaciens Kurth. (Bacillus pseudodiphtheriticus alcalifaciens Kurth, Ztschr. f. Hyg, 28, 1838, 429; ibid., 431) From patients suspected of having diphtheria

Bacillus avium Migula (Bacillus de la diphthérie aviaire, Loir and Ducloux, Ann. Inst Past, 8, 1834, 599, Bacillus diphthériae avium Kruse, in Flügge, Die Mikroorganismen, 2 Auft, 2, 1896, 410; Bacterium diphtheriae arium (sic) Chester, Ann. Rept. Del. Col. Agr Exp. Sta., 9, 1807, 75, Migula, Syst d Bakt., 2, 1900, 759.) Considered the cause of a diphtheria-like disease of birds in Tunis. Motile. Not now regarded as belonging in Corymebacterium (Andrewes et al., Diphtheria, London, 393).

Bacillus claratus Kruse and Pasquale (Kruse and Pasquale, Ztechr. I. Hyg. 16, 1894, 50 and 62; not Bacillus classus Migula, Syst. d. Bakt., 2, 1900, 591.) From the heart blood, kidney, etc., daring autopsy of a persoa who ded will liver abscesses following Egyptan dysentery. This is a pseudodiphered (Kruse, in Flügge, Die Mikroorganisma, 3 Aufl., 2, 1806, 477) but is confused by Eberson (Jour. Inf. Dis., 25, 1918, 5) and Thomson and Thomson Ann. Pletti Thomson Res. Lab., 2, 1926, 63) with

1894, 290) from boiled mark and mane. Bacillus clavatus by Migula (loc. cit) in 1900.

Bacillus crassus Lipschütz. (Lipschütz, Bakt. Grundriss und Altas der Geschlechtekrankheilen, Leipzig, 1915, 04; Plocamobacterium crassum Löss, Wiener klin. Wehnschr., 35, 1920, 733.

dant Gram-positive bacillus found as ulcus vulvae acutum. It is the type species (monotypy) of the genus Piecamobacterium Löwi (for. ct.). According to Löwi this organism liquefice societated blood serum and Lipschitz (Ced f. Bakt., I Abt., Orig., 88, 1922, 5) report that, unlike lactobacilli, this organism will grow on protein media without the addition of sugar. Presumably therefore it is not a lactobacillus and is not identical with Doederlein's bacillus as claimed

<sup>\*</sup> Prepared by Dr. R F Brooks, New York State Experiment Station, Geneva, New York, September, 1938; further revision by Prof Robert S. Breed, New York State Experiment Station, Geneva, New York, March, 1945

hy Lehmann (loc. cit.) It may belong in Corynebacterium. See Bacillus raginae Kruse.

Bacillus diphtheriae ritulorum Flügge (Bacillus der diphtherie heim Kafbe, Löffler, Mitt. a. d. kais Gesundheitsamte, 2, 1884, 421; Flugge, Die Mikroorganismen, 2 Aufl., 1886, 265) From a disease of ealwes.

Bacillus diphtheroides Klein. (Cent. f. Bakt, I Aht, 28, 1900, 418) From bovine mastits. Presumably identical with Corynebacterium pyogenes according to Eherson (Jour Inf Dis., 25, 1918, 6).

Bacillus endocarditis griseus Weichselhaum. (Welchselbaum, Beitrigez path. Anat u. aligem. Path. 4, 1857, 119.) From a case of endocarditis. A motile form Regarded by Kruse (in Flügge. Die Mikroorganismen, 3 Aufl., 2, 1896, 433 and 470) as a diphtheroid. Because of its motility, it is not so regarded by

Eberson (Jour. Int. Dis., 23, 1913, 4).

Bacillus pseudodyphtheriticus acidum
aciens Kurth. (Ztschr. f. Hyg., 28,
1893, 431.) From patients suspected of

having diphtheria.

Bacillus pseudodiphtheriticus gazogenes Jacobsen. (Ann. Inst. Past., 22,
1908. 308.) From faces. Reported to

1908, 308) From feces. Reported to he a vigorous gas former. Eherson (Jour Inf. Dis, 23, 1918, 9) thinks this was an impure culture.

Bacillus septatus Gelpke, in V. Gracle, Arch f. Opthal, 42, 1826, No 4; Bacterum septatum Gelpke, Arb. bakt. Inst. Karlsruhe, 2, Heft 2, 1898, 73 ) From acute epidemic catarth. Presunably identical with Corynebacterum zerose according to Eberson (Jour. Inf. Dis., 23, 1918, 33).

Bactllus variabilis [pmphae vaccinalis Nakanishi. (Nakanishi, Cent. f. Bakt., I Abt., Orig., 27, 1900, 641; Corynethrix boris Czaplewski, Deutsche med. Wednisch; 76, 1000, 723 J. From call vaccino lymph. The organisms listed here as Corynebacterium taccinae and Bacillus variabilis [pmphae vaccinalis, Corynebacterium taccinae and Bacillus variabilis [pmphae vaccinalis are probably identical.

Bacillus zerosis rariolae Klein. (Rept. Local Gov. Board, London, 20, 1890, 219, quoted from Thomson and Thomson, Ann. Pickett-Thomson Res. Lab., 2, 1926, 121.) From vaccine pustules.

Bacterium acnes Migula. (Bacillus der Akne contagisas des Pferdes, Dicekerhoff, Grawitz, Arch. f., pathol. Anat. u. Physiol., 102, 1886, 148; Bacillus graustris Trevsan, I. generi e le spece delle Batteriacce, 1889, 13; Bacillus acnes-contagioace Kunee, in Flügge, De Mikroorganisguen, 3 Aufl., 2, 1800, 445; Migula, Syst. d. Bakt., 2, 1800, 385; Bacterium graustrist Chester, Manual Determ Bact., 1901, 154.) From pus and scabs of pustules in acne-contigiosas in horses.

Bacterium candidus Galli-Valerio. (Cent. f. Bakt., I Abt., Orig., 56, 1904, 465.) From infected leg, but not con-

sidered causative.

Bacterium coelicolor Müller (Müller, Cent. i Bakt., I Abt., Orig., 46, 1908, 195, Becillus coelicolor Godfrin, Contribution à l'étude des bactéries bleues et violettes, Thèse, Nancy, 1934) Contaminant on serum ager plate.

Bacterium columbarum Migula. (Bacillus der diphtherie bei der Taube. Löffler, Mitt n d. kais. Gesundheitsamte, 2, 1881, 421, Bacillus diphtheriae columbarum Flugge, Die Makroorganismen, 2 Aufl., 1886, 263; Bacillus diphtheriae-columbarum Trevisan. I generi e le specie delle Batteriacee, 1889, 13. Bacterium diphtheriae columbarum Chester, Ann Rept. Del Col. Agr. Exp Sta , 9, 1897, 84, Migula, Syst d Bakt , 2, 1900, 381, not Bacterium columbarum Chester, Manual Determ. Bact., 1901, 141; Baclerium diphtheriae Chester, Man Determ Bact , 1901, 141; not Bacterium diphtheriae Migula, Syst d. Bakt., 2, 1900, 499 ) Associated with diphtheria in pigeons. Andrewes et al (Diphtheria, London, 1923, 393) state that this organism does not belong in Corunebactersum.

Bactersum muris Klein. (Cent. f

Bakt., I Abt., Orig., 53, 1902, 488; Bacillus muris Mellon, Jour. Bact., 2, 1917, 305.) Causative agent of hepatized lung in white rat.

Bacterium pseudopestis murium Galli-Valerio. (Cent. f. Bakt., I Abt., Orig., 68, 1913, 188.) Causative agent of thyroid infection in rats Gram-negative

Bacterium ribberti Migula. (Bacillus der Darmdiphtherie des Kaninchens, Ribbert, Deutsch. med. Wochnschr., 18, 1887, 141; Bacillus diphtheriae cuniculi Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 412; Bacterium diphtheriae cuniculi Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 84; Migula, Syst. d. Bakt., 2, 1900, 309; Bacterium cuniculi Chester, Man. Determ. Bact., 1901, 141.) Associated with a diphtheritie inflammation of the intestines in rabhits.

Coccobacillus diphtheroides Manteufel. (Diphtheroid bacilli, Collis, Sheldon and Hill, Quart Jour. Med., Ser. 2, 1, 1932, 511; Kokkobacillus diphtheroides Bertrand, Med. Welt, 8, 1934, 150, Manteufel, Cent. 1 Bakt, I Abt., Orig., 158, 1937, 308) From polyarthritis.

Comma variabile Heurlin. (Heurlin, Bakt Unters. d. Kelmgehaltes im Genitalkanale d. fiebernden Wochnerinnen. Helsingfors, 1910, 145.) From genital canal

Corynebacterium acidum Eberson. (Bacillus diphtheroides brevis Gmham-Smith, Jour Hyg., 4, 1904, 258, Eberson, Jour. Inf. Dis., 23, 1918, 9.) From large abscess in mouth and ear.

Corynebactersum adamson; Prévot. (Bacillus D, Adamson, Jour. Path. and Bact, 22, 1919, 350 and 392, Prévot, Ann. Inst. Past., 60, 1938, 304.) From infected war wounds.

Corynebactersum album Belenky and Popova. (Cent. f. Bakt, I Abt, Orig., 118, 1930, 444) From normal skin of calves and small-pox vaccine.

Corynebacterium angerobium Prévot. (Bacillus anaerobius diphtheroides Massini, Ztschr. f. gesammte exper. Med., 2, 1913, 81; Prévot, Ann. Inst. Past., 60, 1938, 304.) From a complicated case of otitis media.

Corpuebacterium annamensis Husérroy et al. (Gillon, Thèse pour le Detorat Vetérinaire, École Nationale Vetiinaire de Toulouse, France, 1939, Hauduroy et al., Diet. d. Best. Pat., Paris, 1937, 145.) Causstive agent of a toxic abdominal infection of sheep in Annam, French Indo-China.

Coryacoacterium arthritidus mun Fischl, Koech and Kussat. (Itsch. I. Hyg., 118, 1931, 421; Coryacoactaium arthritidis-muris Hauduroy et al., Dat. d. Baet. Path., 1937, 147.) Causior agent of infected ankle joint in suit

Corynebacterium ascitis Eberson. (Jour. Inf. Dis., 25, 1918, 16) From ascitic fluid.

Corynebacterium aurantiacum Eberson (Jour. Inf. Dis , 23, 1918, 14.) Omerred growth. From lymph nodes, owe culture from gland in Hodgkin's disease but not specific for the disease.

Corynebacterium ouris (Graham-Smith) Eberson. (Bacillus ouris Graham-Smith, Jour. Hyg., 4, 1904, 288; Eberso, Jour. Inf. Dis., 23, 1918, 8.) Indole is formed. From pas of ears of scalet fever patients.

Corynchecterium acidum (Egetth)
Prévot. (Bacteroides acidus Egerth.
Jour Bact., 30, 1935, 293; Prévot, An.
Inst. Past., 60, 1938, 394.) Forms 18
in some media. From the human intet
tine. Pederson (Jour. Bact., 50, 1935,
478) secured a culture of this specie
from Eggerth, and found that it fer
mented glucose with the production of
higher fatty (presumably butyric) acid,
and lactic acid. The species shoul
probably be placed in Butyribacterium
probably be placed in Butyribacterium.

Corgnebacterium blattelles Glaser.
(Jour. Exp. Med., 61, 1939, 997.) Found
in the fat body of the German ocknock
(Blattella germanica). For a more corplete description see Manual, 5th ed.
1930. 978.

Corynebacterium brinneum Kisskalt and Borend. (Bacterium brinneum 7 inborescens, quoted from Kisskalt and Berend, Cent. f. Bakt, I Abt, Orig, 81,1918,446; Kisskalt and Berend, idem ) Source not given.

Corynebacterium cerebralis Eberson (Jour. Inf. Dis, 23, 1918, 17.) From the brain in a case of meningitis

Corynebacterium ceruminis (Graham-Smith) Eberson. (Bacillus ceruminis Graham-Smith, Jour. Hyg., 4, 1904, 225; Eberson, Jour. Inf. Dis., 23, 1918, 8.) Indole is not formed. From rormal and scarlet fever-infected ears.

Corynebacterium commune Martin (Compt. rend. Soc. Biol., Paris, 81, 1918, 991 and 998) From the pharyns

Corunehaclerium cremoides (Lehmann and Neumann) Jensen. (Bactersum cremordes Lehmann and Neumann, Bakt. Disg., 1 Aufl., 2, 1896, 253; Jensen, Proc Linn, Soc. New So. Wales, 59, 1931, 40) From tapwater, Wurzburg, Lehmann and Neumann recognize this species as a Corunebacterium in the seventh edition their determinative bacteriology (Bakt. Diag., 7 Aufl., 2, 1927, 719) but do not use the binomial Corynebacterium cremoides except in the index, page 848. Jensen has reisolated this organism from soil in Australia. Baclersum cocciforme Migula (Kultur No 2, Severin, Cent. f. Bakt., II Abt., 1, 1895, 160; Migula, Syst. d. Bakt., 2, 1900, 439) from manure is regarded by Jensen (loc. cit) as closely related to this apecies.

Corpnebacterium cucvii (Graham-Smith) Bergey et al (Bacillus cucul: Graham-Smith, Jour. of Hyg., 4, 1994, 315; Bergey et al., Manuel, 1at d., 1923, 337) From the throat of a cuckoo For a more complete description ace Manual, 5th cd., 1939, 502.

Corynchacterium cuniculi Hauduroy et al. (Bacillus pyogenes cuniculi Commotti, Clinica Veterinaria, 44, 1921, 45, Hauduroy et al., Diet. d. Bact. Path., 1937, 147). Reported as Gram-variable by Cominotti, as Gimm-negative by Hauduroy et al. Causative agent of auppurative infection of rabbit.

Corpusbacterum cutis Haudmoy et al. (Bacrillus cutis communis Nicolle, quoted from Costa, Troisser and Dauvaugne, Compt. rend. Soc. Biol., Pars, 81, 1918, 1903; Bacıllus cutis Costa, Troisser and Dauvaugne, thid, 1904; Bacterium cutis commune Nicolle, quoted from Debré and Letulle, Le Presse Méd, 27, 1919, 515; Hauduroy et al., Diet, d. Bact. Path., 1937, 148) From normal skin and nasta passages.

Corynebactersum delicatum Eberson. (Jour. Inf Dis., 23, 1918, 16.) From ascitte fluid. Also from blood.

Corynchacter:um dermophilum (Rohlod) Andrews et al. (Bacillus dermophilus Rohlot, Munch. med. Weinschr., 68, 1921, 234; Andrewes, Bulloch, Douglas, Dreyer, Fildes, Lednigham and Wolf, Diphthera, London, H. M. Stationery Office, 1923, 391) From the skin

Corymbacterium diphtheroides Prévot. (Bacille diphtheroide, Jungano, Compt. rend Soc Biol., Paris, 61, 1909, 112; Prévot, Ann Inst. Past, 60, 1933, 304) Forms gas in some media. From the intestines of white rats.

Corynchacterium epidermidis Eberson. (Jour. Inf Dis, 23, 1918, 17.) From skin and pus pockets. Resembles Corynchacterium suppuratum Eberson

Corynchacterium flocculens Eberson. (Jour Inf Dis , 23, 1918, 17.) From a case of appendicitis.

Coryachactersum gallmarum Berrge et al (Bacillus diphikroudes gallmarum Graham-Smith, Jour of Hyg., 4, 1901, 314, Bergey et al., Manual, 1st ed., 1923, 387) From the throats of chickena For a more complete description see Manual, 5th ed., 1939, 502.

Corynebacterium glandulae Liberson. (Jour. Inf. Dis , 23, 1918, 14.) From lymph glands in Hodgkin's disease but not specific for the disease

Corynebacterium granulomatis maligni de Negri and Miercmet. (Cent f. Bakt, I Abt., Orig., 63, 1913, 292) Causative agent of human malignant granuloma. Corynebacterium granulosum Prévot. (Bacille granuleux, Jungano, Compt. rend. Soc. Biol., Paris, 66, 1909, 123; Prévot, Ann. Inst. Past., 60, 1938, 304.) From the intestiaes of white rats.

Coryncbacterium hepatodystrophicans (Kuesinski) Prévot. (Bacillus hepatodystrophicans Kuesinski, Der Erreger des Gelbfiebers-Wesen und Wirkung, Monographie, 1929, Berlin; Prévot, Ann. Inst. Past., 60, 1938, 304.) Manteufel (Cent. f. Bakt., I Abt., Orig., 138, 1937, 309) regards this species as identical with Bacillus renale (cunicut)) Manteufel and Herzberg. Common in the organs of monkeys infected with vellow fever virus.

Corynebacterium hodgkınıi Bunting and Yates. (Bunting and Yates, Arch. Internal Med , 12, 1913, 236; Johns Hopkins Hosp. Bull., 25, 1914, 173; Bacillus hodgkini Mellon, Jour. Bact., 2, 1917, 271; Fusiformis hodakini Holland, Jour. Bact., 5, 1920, 223 ) From lymph glands in Hodgkin's disease. Not pathogenic. Thought by Fox (Jour. Med. Res., \$2, 1915, 309) and Eberson (Jour. Inf. Dis, 23, 1918, 11) not to represent a definite species Eberson recognized four separate species isolated from human lymph glands, three being from glands in Hodgkin's disease (Corynebacterium aurantiacum, C. pseudodiphtheriae, C. glandulae and C lymphophilum)

Corynebacterium liquefaciens Prévot. (Bacillus parvus liquefaciens Jungano, Compt rend Soc. Biol , Paris, 65, 1908, 618; Prévot, Ann. Inst. Past., 60, 1938, 304, not Corynebacterium liquefaciens Andrewes et al., Diphtheria, London, 1923, 408; not Corynebacterium liquefaciens Jensen, Proc. Linn. Soc. New So. Wales, 69, 1934, 49.) From human intestunce

Corynebacterium liquefaciens Andrewes et al (Bacillus diphtheroides liquefaciens Graham-Smith, Jour Hyg., 4, 1904, 258, Bacillus liquefaciens Mellon, Jour-Baet, 2, 1917, 290; Andrewes, Bulloch, Doughis, Dreyer, Fildes, Ledingham, and Wolf, Diphtheria, London, 1923, 409.) From mouth of n patient. MotileCorynebacterium lymphae taccinels Levy and Fickler. (Deutsch. med. Wchnschr., 28, 1900, 418; Corynebacterium pyogenes Lewandowsky, Cent. f. Bakt., I Abt., Orig., 38, 1904, 473.) From animal lymph.

Corynebacterium lymphophilum (Torrey) Eberson. (Bacillus lymphophilu Torrey, Jour. Med. Res., 34, 1916, 79; Eberson, Jour. Inf. Dis., 23, 1918, 21) Anaerobie. From lymph glands in Hodgkin's disease, but not specific for the disease.

discuss.

Corynchacterium maculatum (Graham-Smith) Ford. (Bacillus maculatus Graham-Smith, Jour. Hyg., 4, 1904, 28; Ford, Textb. Bact., 1927, 277.) From throat. Regarded as a Corynchacterium by Eberson (Jour. Inf. Dis., 25, 1918, 7).

Dy Eberson Golt. Int. Day 22, 2007. Corynebacterium metrits. Haudury et al. (Souckin, Sovetskaia Veter., No II, 1934; Haudury et al., Diet. d. Bat-Path., 1937, 156.) Causative agent of metritis in rabbit.

metritis in radou.

Corynebacterium multinum Kisskalt.

Quoted from Kisskalt and Berend,
Cent. f. Bakt., I Abt., Orig., 81, 1915,
446). Source not given.

Corynchacterium nodosum (Migula)
Eberson. (Bacillus nodosus perus
Lustgarten-Mannaberg, Vicetelpirs
schrift f. Dermatol. u. Syphilis, 183,
914; Bacterium nodosum Migula, Syt-d.
Bakt., 2, 1900, 416; Eberson, Jour. Id.
Dis., 25, 1918, 4.) Found in the normal

human urethra. Corynebacterium nubilum (Frankland and Frankland) Jensen. (Bacillus nu bilus Frankland and Frankland, Zischt. Hyg., 6, 1889, 386; Bacterium nubilum Lehmann and Neumann, Bakt. Disg. 1 Aufl., 2, 1896, 255; Chromobacterium nubile Ford, Textb. of Bact., 1927, 472, Flavobacterium nubilum, incorrectly ascribed to Bergey, by Jensen, Proc. Linn. Soc. New So. Wales, 59, 1934, 44; Jensen, idem.) From water and soil. The identity of this species is doubtful. The original description by the Franklands is incomplete. Zimmerman (Bakt. unscrer Trink- u. Nutzwässer, Chemnitz, 1,

ganism and described it as Gram-negative. Lehmann and Neumann (Bakt. Diag , 1 Aufl., 2, 1896, 255) who studied one of Zimmermann's cultures reported this culture as Gram-positive and nonmotile, while the Franklands and Zimmermann speak of an active, circular motility of the very slender rods. Lebmann and Neumann later (Bakt. Diag., 7 Aufl., 2, 1927, 710) list their Bacterium nubilum (with other Gram-positive, nonmotile rods) as a possible Corynebacterium. Jensen failed to find anything that exactly corresponded to any of these descriptions hut describes a small, Gram-positive, poorly-growing, pink to red, slow golatin-liquelying rod which he says has little in common with corvnebacteria as a new variety Corynebacterium nubilum var. nanum. Because the early cultures developed rhizoid growths in stiff gelatin before liquefaction, Zimmermann originally planned to call this species Bacillus nebulosus (loc. cit., 20). a name that has been used by later authors for several different organisms. Attention should be called also to Bacillus caudatus Wright, an organism which Conn found to show occasional motility (polar) and named Pseudomonas caudadatus This common, siender, gelatinliquefying, Gram-negative, white to yellow chromogenic rod is much like the Franklands' and Zimmermann's organ-18m (see Conn. New York State Exp Sta Tech Bull. 67, 1919, 38).

1890, 28) thought he found the same or-

Corpnebacterium paralyticans (Robertson) Ford (Bacillus paralyticans Robertson), Rev. Neurol. and Psychiat, Edinburgh, 1, 1903, 470; Ford, Tevtb. of Bact. 1927, 281.) From ererbrospinal fluid A diphtheroid Thought at one time to be the causal agent of general paralysis

Corynchacterium parrum Prévot. (Corynchacterium parrum infectiosum Mayer, Cent. f. Bakt, I Abt, Orig., 98, 1926, 370; Prévot, Man. de Class. et Déterm. des Bactéries Anaérobies, Monographic, Inst. Past., Paris, 1940, 202.) From blood in a post-natal fever.

Gorynebacterium persplanetae Bergey et al. (Corynebacterium persplanetae var. americana Glaser, Jour. Exp. Med., 51, 1930, 59; Bergey et al., Manual, 4th ed., 1931, 550 ) Found in the fat body of the American cockroach (Persplaneta americana). For a more complete descreption see Manual, 5th ed., 1839, 798.

Corynebacterium plumosum (Fox)
Ford. (Mycobacterium plumosum Fox,
Cent. f. Bakt., I Abt., Orig., 70, 1913,
148; Ford, Texth. Bact., 1927, 281.)
From blood of patient with chronic endocarditis.

Corynebacterium pseudodiphtheriae Eberson. (Jour. Inf. Dis., 23, 1918, 14.) Hemoglobinophilic From tonsils.

Corynebacterium putidum Eberson.
[Bacillus diphtheroides liquefacens
Graham-Smith, Jour. Hyg., 4, 1904, 258;
Eberson, Jour. Jol., Dis., 25, 1918, 16.)
From mouth Cultures described by
Graham-Smith liquefied gelatin and were
stuggishly motile.

Corprebatterum pyogenes bovis (Roux)
Prévot (Bactilus pyogenes bours Roux)
Cent I Bakt, I Abt., Orig, 34, 1005, 541;
Evboterterum pyogenes boues Prévot, Ann.
Inst. Past., 60, 1038, 205; Prévot, Man.
de Class. et Déterm. des Bactéries Anaérobies, Monographie, Inst. Past., Paris, 1310, 204.)
Common in bovine suppurations. Said by Roux to be identical with Bacillus pyogenes bous Kunnemann.
Prévot says it as probably identical with the pyogenie Corprebaterium of Lucet.
See Corprebaterium popenes Elberson.

Corpnebacterium renale cunsuli Prévot. (Bacterium renale and Bacterium renale (cuniculi) Manteufel and Herzberg, Cent. I Bakt, I Abt., Orig, 116, 1939, 296; Bacillus renale and Bacillus renale (cuniculi) Manteufel, ibud., 153, 1937, 306; Prévot, Ann. Inst., Past., e0, 1938, 304.) Gram-variable. From rabbit kidneys.

Corynebacterium ruedigers (Mcllon)

Ford. (Virulent pseudodipbtheria bacillus, Hamilton, Jour. Int. Dis., 1, 1904, T11; Ruediger's bacillus, Mellon, Jour. Bact., 2, 1917, 285; Bacillus ruedigeri Mellon, ibid., 290; Ford, Textb. Bact., 1927, 274.) From throats of fatal cases of scarlatine.

Corynebacterium segmentosum son. (Bacillus coryzae segmentosus Cautley, Rept Med. Officer of Health. Local Govt. Board, London, 1894-95, 455; Bacillus septus Benham, Brit, Med. Jour., 1, 1906, 1023; Eberson, Jour. Inf. Dis., 23, 1918, 17; Bacillus segmentosus Holland, Jour. Bact., 5, 1920, 220.) Rods of variable dimensions, mostly resembling Corynebacterium pseudodiphtheriticum Lehmann and Neumann, but oecasionally resembling Corunebacterium diphtheriae Lehmann and Neumann. Thomson and Thomson (Ann. Pickett-Thomson Res. Lab , 2, 1926, 65) do not think Cautley's bacillus is recognizable. From nasal secretions

Corynebacterium squamosum Belenky and Popova (Cent. f. Bakt., IAbt., Orig., 118, 1930, 444.) From normal skin of ealves and small-pox vaccine. Nonhemolytic

Corynebacierium striatum (Chester) Eberson. (Bacillus striatus flavus and Bacıllus striatus albus von Besser, Beitr. z path. Anat. u Path., 6, 1888, 349; Bacterium striatus flavus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta , 9, 1897, 111: Bacterium striatum Chester, Man. Determ. Bact., 1901, 171, Bacillus flavidus Morse, Jour. Inf. Dis., 11, 1912, 281; Corynebacterium flavidum Holland, Jour. Bact , 5, 1920, 218; Eberson, Jour. Inf Dis . 23. 1918. 5.) Eberson (loc. cit., 7) states that Bacillus diphtheroides citreus Graham-Smith (Jour. Hyg., 4, 1904, 258) corresponds with the yellow variety of this species From nasal mucus. Resembles Corynebacterium segmentosum

Corynebacterium suis Hauduroy et al. (Le bacille pyogenes suis, Colin aud Rossi, Revue gén. de Méd. vetér., 40, 1931, 137; Hauduroy et al., Diet. d. Bact. Path., 1937, 167). Causative agent of caseous suppuration of swine. Gramnegative.

Corynebacterium suppuratum Eberson. (Jour. Inf. Dis., 28, 1918, 17.) From anal pus pocket. Resembles Corynebacterium epidermidis Eberson.

Corynebacterium thermophilus Zavagh (Amer. Jour. Hyg., 15, 1932, 504.) From raw and pasteurized milk. Grows better at 55°C than at 37°C.

Corunebacterium typhi Topley and Wilson. (Bacillus typhiexanthemalici Plotz, Jour. Amer. Med. Assoc., 62, 1913, 1556; La Presse Méd., 48, 1914, 411; Plotz, Olitsky and Bachr, Jour. Inf. Dis, 17, 1915, 17; not Bacillus typhi exanthematica Klebs, Proc. Internat. Med. Cong , 1, 1831, 323; Corynebacterium typhi-eranthematici Eberson, Jour. Inf. Dis, 13, 1918, 19; Bacterium typhi-exanthematici Holland, Jour. Bact., 5, 1920, 222; Funform is typhi-exanthematici Holland, soid, 221; Topley and Wilson, Prin. of Bact. and Immun., 2nd ed., 1936, 349; Eubacterium typhi-exanthematici Prévot, Ann Inst. Past., 60, 1938, 295.) From blood of typhus fever patients.

Corynebacterium ulcerogenes Bergy et al. (Corynebacterium diphtheries dicerogenes cutaneum Mrongovius, Cett.i. Bakt., I Abt., Orig, 112, 1929, 51, Bergey et al., Manual, 4th ed., 1934, 53) From ulcerations of the skin (humal). Resembles Corynebacterium epidemiks Eberson and C. suppuratum Eberson

Corynebacterium raccinae Galli-Valerio (Cent. f. Bakt., I Abt., Orig., 56, 1904, 465.) From vaccine pustules in calves Corynebacterium zerosis cans

(Graham-Smith) Ford. (Bacillus 200sis canis Graham-Smith, Jour. Hys. 4, 1904, 255; Ford, Textb. Bact., 1927, 211) From conjunctival sacs of dogs

Corynethriz hominis, C. equi, C. cesti, C. canalis, etc. Czaplewski. (Deutsche med. Wehnschr., 86, 1990, 723) Hypothetical species from the skin of the animals indicated.

Corynethrix pseudotuberculosis murium Bongert. (Ztschr. f. Hyg., 57, 1901, 472.) From a multiple, necrotic, caseous pneumonia of mice inoculated with material from equinc pneumonia. Regarded by the author as distinct from Bacillus pseudotuberculosis murium Kutscher. Placed in the genus Corynethriz Czaplewski (Deutsche med. Wehnschr. 26, 1900, 723)

Lactobacillus meleagratus Johnson and Pollard. (Diplo-bacillus Pi, Johnson and Anderson, Jour. Inf. Dis., 68, 1936, 349. Johnson and Pollard, Jour Inf. Dis., 68, 1910, 1905. From heart, Iwer and yolk of moribund turkey poults. Presumably a Cosymbacterium, not a true Lactobacillus.

Einer sporogenen Pseudo-Diphtheriebanilus, De Simoni (Cent. f. Bakt, I Abt, Orig, 24, 1898, 291) From nasal secretion in ozena. Produced spores only in milk and on potato Thought by Eberson (Jour. Inf. Dis., 25, 1918, 6) to have been a contaminated culture

Organism in M. H., De Witt. (Jour Inf. Die., 10, 1912, 40.) A mottle, gasproducing diphtheroid isolated from a generalized diphtheria-like infection.

Appendix III: The relationships of the following coil organism are not clear, but it apparently should be placed either in Corynebacterium or in a related genus (e g . Mycobacterium) On agar it is rodshaped and generally Gram-negative in young cultures, but coccoid and Grampositive in old cultures, a condition noted by Mellon (Jour Bact , 2, 1917, 278) in connection with Corunebacterium enzymicum Something similar is noted by Jensen (Proc. Linn Soc New So Wales, 59, 1934, 29-62) in his description of Corynebacterium helvolum Krassilmkey, on the other hand (Cent I Bakt . II Abt , 90, 1934, 432), suggests that this species really belongs to Mucobacterium, and, after seeing a culture furnished him by Conn, has become all the more convinced of this relationship (personal correspondence)

Krassilnikov'e etudies indicate that there is a group of soil bacteria that grow as rods in young cultures with a tendency to produce branching forms in liquid media and develop coccoid bodies as they grow older. The latter then even divide and multiply like cocci He conaidere that practically all so-called micrococci found among soil cultures are really the older etages of Mycobacterium spp. It is very clear that Jensen and Krassilnikov, the two leading etudents of the saprophytic members of this group found in coil, do not agree as to what constitutee the genus Mucobacterium: their papers appeared almost simultaneously and clearly represent independent work. Krassilnikov'e description of this genus comes closest to covering organisms like the following of any of the descriptions in the literature, but it ie quite different from Jensen's idea of the genus In fact, the descriptions given by the former author seem to be more like Jensen's conception of the genus Corynebacterium Jensen, in his description, takes into account the relative acid-fast etaining properties of the groups, but Krassilnikov does not mention either this property or the Gram stain Inasmuch as the acid-fast propcrty is regarded in the present classifica. tion as an important characteristic of Mycobacterium, the following species is included as an appendix, not of that genus, but of Corynebacterium. The relationships of these pleomorphic soil organisms must be regarded as decidedly obscure Lochhead (Can Jour Res. Sec C, 16, 1938, 156) speaks of a Bactersum globsforme group and Conn (Jour. Bact , 48, 1945, 359) has recently reported evidence in support of Lochhead's viewpoint In all probability this group is identical in whole or in part with Krassilnikov's Mucobacterium of soil, although the correctness of his choice of this generic name may be questioned

<sup>\*</sup>Prepared by Prof. II J. Conn, New York State Experiment Station, Geneva, New York, July, 1945.

Batterium globiforme Conn. (Conn, N. Y. Agr. Exp. Sta. Tech. Bull. 183, 1923 and 172, 1930; Cent. f. Bakt., II Abt., 76, 1923, 77; Achromobacter globiforme Bergey et al., Manual, 3rd ed., 1930, 226.) From Latin, having the form of n globe or sphere.

Shurt rods. 0.4 to 0.6 by 0.6 to 0 8 micron, becoming eoccoid in older cultures. In certain liquid synthetic media, branching forms with Cram-positive spherical granules are common. These granules have a tendency to be acid-fast. Non-mottle. Rods usually Cram-negative; ecceoid forms usually Cram-posi-

Gelatin colonies: Circular, punctiform. Gelatin stnb: Slow crateriform lique-

Agar colonies Circular, punctiform, translucent.

Agar slant: Filiform, flat, smeeth, soft, translucent, glistening growth with translucent sheen.

Broth: Slight growth

Nitrites produced from nitrates in synthetic agar media.

Glucose, sucrose, mannitol, and less readily lactose and various organic acids are utilized as sources of carbon and energy when grown in synthetic media No visible gas production, and probably no acid except earbonic acid

Nitrogen may be obtained from an monium sulfate, asparagine, cystine, glycerol, aspartic acid, uric acid, tyresin, potassium nitrate, urea and peptone

Aerobic, facultative.

Optimum temperature 22°C.

Source Seventy cultures isolated from soil. Habitat: Widely distributed in soil

## Genus II. Listeria Pirie.\*

(Listerella Pirie, Publ. So. African Inst. for Med. Res., \$, 1927, 163; not Listerella Jahn, Ber. d. deutsch. Bot. Gea., 24, 1906, 538; not Listerella Cushman, Contr. Cushman Lab. Foram, Sharon, Mass., 9, 1933, 32; Pirie, Science, 91, 1940, 333.) Named for Joseph Lister, the English surgeon and bacteriologist.

Small rods, Gram-positive. Flagellation peritrichous. Aerobic. Catalase pesitive. Grow freely on ordinary media. Acid but no gas from glücose and a few sciditional carbohydrates. Patbogenic parasites. Infection characterized by a mondevtosis. Parasitic on warm-blooded animala.

The type species is Listeria monocytogenes (Murray et al.) Pirie.

 Listeria monocytogenes (Murray et al.) Pirie (Bacterium monocytogenes Murray, Webb and Swann, Jour. Path, and Bact., 29, 1926, 407; Listerella hepatolytica Parie, Publ. S. African Inst. for Med. Res., 3, 1927, 164; Listerella monocytogenes Pirie, ibid.; Listerella monocytogenes hominis Nyfeldt, Folia Haematologica, 47, 1932; Corynebacterium parvulum Schultz, Terry, Brice and Gebhardt, Proc. Soc. Exp Biol. Med., 31, 1934, 1021; Pirie, Science, 91, 1940, 383; Bacillus monocytogenes Tobia, Arch. ital. med colon., 23, 1942, 219; ahst. in Cent. f. Bakt., I Abt., Ref., 144, 1943, 199 ) Derived from the Greek, meaning generating monocytes.

Small rods: 0.4 to 0.5 by 0.5 to 20 microns, with rounded ends, slightly curved in some culture mecha 0-cer singly, in V-shaped or parallel pairs and in short chains. Motile, peritriches (Taterson, Jour. Path and Back., 48, 1939, 25) with four flagella at crinary temperatures with tendency toward non-motility or single flagellum at 37°C (Griffin, Jour. Back., 48, 1944, 114). Not acid-fast. Gram-positive

Gelatin: No liquefaction. Growth is confined to the needle track.

In 0 25 per cent agar, 8.0 per cent gelatin, 1.0 per cent glucose semisolid medium, growth along the stab in 24 hours at 37°C, followed by irregular cloudy or

Revised by Prof. E. G. D. Murray, McGill Univ., Moatreal, P. Q., Canada, September, 1938; further revision, January, 1945.

granular extensions into the medium; growth does not spread through the entire medium. This is characteristic (Seastone, Jour. Exp. Med., 62, 1935, 933)

Sheep liver extract agar colonies. Curcular, smooth, slightly flattened, transparent by transmitted and milk-white by reflected light. Viscid.

Sheep liver extract agar elant Confluent, flat, transparent, viscid growth. Peptone agar: Growth is thinner than

on liver extract agar.

Blood agar: Improved growth with
zone of hemolysis around colonics

Peptone broth, Surface film with flocculent sediment.

latmus milk: Slightly acid, decolor-

ized No congulation Glycerol-potato: No apparent growth Insplasated ox serum: Grows as a very

thin, transparent film

Doriet's egg medium: Very thin film
Indole not formed.

Hydrogen sulfide not formed

Nitrites not produced from nitrates.

Acid but no gas from glucove, rhamnove, and sahem promptly, more slowly from deatran, successe, soluble starch and glycerol. Acid production may be earthade and slow from mattose and lactore. No action on arabinove, galactore, 23 love, mannitol, ductool, intuit and soverable.

All cultures give off a penetrating, rather unpleasant acid smell

treobie, facultative

Optimum temperature 37°C. Ther mad death point 55° to 51°C in 10 runnter Annual insociation. Injection of rabits with cultures results in a very marked interior in resocytes circulating in the liked. This is the most striking character of the organism and be cultured by attains derived from all sources. Infection is characterized by meeting for in various organs.

Sent qued characters: Agglutination and also spison of agglution resetting stoma warration in degree with different attense i at there is no deficite indicatem it at attaces for middlerent kinds of arinal Loste are different species. Paterson (Jour. Path, and Bact., 67, 1910, 427) concludes from his studies of the flagellar and somatic antigens of 31 cultures that four types may be recognized in this species. These do not bear any relation to the host species or to the geographical area from which they were isolated.

Possibly related to Erysipelothriz (Barber, Jour. Path and Bact., 48, 1939, 11).

Habitat and source: Lesions in organs, blood, cerebrospinal fluid of rabbits, guinea pips, sheep, cattle, forces, hogs, fonds, gerballes and man, in all of which natural disease occurs. Many cases have proved fatal. The cause of Infectious mononucleosis in man (Nyfeldt, loc cit.).

Appendix: The following binomials have also been proposed for species in this genus

Bosterium Aepotis Hülphern (Sven. Vet Tidskrift, 2, 1911, 271.) From necross of the liver of a rabbat. Nyfeldi (Skand Vet Tidskrift, 29, 1910, 281) regards this as a synonym of Listocilla monoplegens. However, fasture to ferment lactors, thannose, sucrose and calicia with fermentation of vylow, and failure to infect guines pays and chickens indicate a possible difference between the two arreies.

Listerello hiliseus liquefaciens Nakyhama. (Jour Agr Chem. Sie Japon, 10, 1910, 345) From retted kenaf (Hilliseus)

Luterdla homma, Interella bena, Laterella gilinarum, Luterella carnella and Luterella gebile Visanley. (Nan 1 Vet Tielanth, 34, 1911, 200). These raises are given to infleate culture of Luterila monophophes in ri man, eatite, chielens, rabbats and geballes, respectively.

Laterella cesa Gill (Amitralian Vet June, 15, 1977, 47) Causes circling disease of sheep

Barn (Jour Part , 57, 1921, 273, sep-ris, but diversit name, a new species in this group.

## Genus III. Erysipelothrix Rosenboeh,\*

(Ztschr. f. Hyg., 63, 1909, 367.) From Greek erysipelas, a disease; and thriz hair or thread.

Rod-shaped organisms with a tendency to the formation of long filaments. The filaments may also thicken and show characteristic granules. Non-motile. Grampositive. Microacrophilic. Catalase negative. Grow freely on ordinary media. Acid but ac gas from glucose and a few additional carbohydrates. Parasitic on mammals.

The type species is Erusipelothrix rhusiopathios (Migula) Winslow et al.

1. Erysipelothrix rhusiopathiae (Migula) Winslow et al. (Bacillus des Schweinerotlaufs, Loeffler, Arb. a. d. k. Gesundheitsamte, 1, 1886, 46; Bacillus thuillieri Trevisan, I generi e le apecie delle Batteriacee, 1889, 13, Posteurella thuillieri DeToni and Trevisan, in Saceardo, Sylloge Fungorum, 8, 1889, 995; Bocillus rhusiopathioe suis Kitt, Bakterienkunde u. path. Mikroscopie, 1893, 284: Bocterium erysipelotos suum (sic) Migula, in Engler and Prantl, Die naturl. Pflanzenfam., 1, 1a, 1895, 24; Boetersum rhusiopothioc suis Chester, Ann. Rept. Del. Col. Agr. Exp Sta., 9, 1897, 98; Bocterium rhusiopothioe Migula, Syst. d. Bakt., 2, 1900, 43; Mycobacterium rhusiopothioe Chester, Man Determ. Baet., 1901, 352; Erysipelothrix porci Rosenbach, Ztschr. f. Hyg, 63, 1909, 367; Winslow et al., Jour. Bact , δ, 1920, 198; Bocillus erysipelatos-suis Holland. Jour. Bact , 5, 1920, 218; Erysipelothrix erysipelatos-surs Holland, abid. Bacillus ruboris suis Neveu-Lemaire, Précis Parasitol. Hum., 5th ed , 1921, 24; Nocardia thuilliers Vusllemin, Encyclopédie Mycologique, Paris, 2, 1931, 125; Actinomyces thuilliers Nannizzi, in Pollacci, Tratt. Micopat. Umana, 4, 1934, 45.) From Greek rhusius, reddish; 1 thus, a disease; red disease.

Description taken in part from Karlson, Jour. Bact., \$5, 1938, 205.

Slender rods: 0.2 to 0.3 by 05 to 1.5 microns, occurring singly and in chains. Non-motile. Gram-positive.

Gelatin colonies: Hazy, bluish-gray,

racemose; situated a little below the surface, growing slowly.

Gelatin stab: Small, fimbriate colonies in the stab, at times definitely arborescent. No surface growth, No lique-

faction. Agar slant: Scant growth, translucent, moist, homogeacous.

Broth: Slight turbidity, with scant,

gravish sediment. Litmus milk: May become slightly acid.

Indole not formed.

Potato: Usually no growth. Blood serum shows scant growth.

No gas from carbohydrates. Acid from glucose, galactose, fructose, lactose and more slowly from mannose and cellobiose. No acid from arabinose, xylose, rhamnose, maltose, melibiose, sucrose, trehalose, raffinose, melezitose, dextru, starch, inulin, amygdalin, glycerol, crythritol, adonitol, manni-

tol, sorbitol, dulcitol or inositol. Esculin not hydrolyzed.

Hydrogen sulfide produced. Voges-Proskauer test negative.

Methyl red test negative. Methylene blue-reduction test nega-

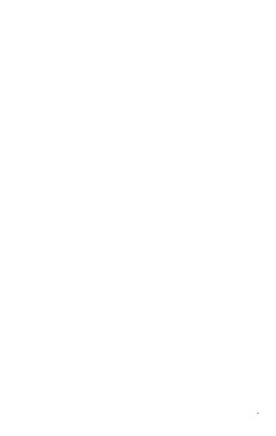
tive. Narrow green zone of hemolysis de-

velops around deep colonies on blood agar.

Catalase negative.

Out of 43 strains studied serologically (Watts, Jour. Path. and Bact., 50, 1940, 355), 38 appeared to be of one antigenic group, and 5 of another.

Revised by Prof. Robert S. Breed, New York State Experiment Station, August, 38: further revision. 1938; further revision, January, 1945.



## FAMILY IX. ACHROMOBACTERIACEAE BREED.

(Jour. Baet., 50, 1945, 124.)

Rods, small to medium in size, cells usually uniform in shape. No branching on ordinary media, if at all. Gram-negative, arely Gram-variable. Peritrichous or no motile. Growth on agar slants non-chromogenie to grayish-yellow, brownish-yellow or yellow to orange. The pigment does not diffuse through the agar. Characterized by lack of power or feeble powers of attacking carbohydrates. May form acid from hexoses but no gas. May or may not reduce nitrates. May or may not liquefy gelstu Do not liquefy agar or attack cellulose, and are not phosphorescent. Litmus mik may become faintly acid but not sufficiently acid to curdle. Usually the restina remains unchanged or becomes alkaline. Generally salt water, fresh water and sal forms and, less commonly, parasites. Some plant pathogens may belong here

## Key to the genera of family Achromobscteriaceae.

Non-chromogenic or at most little or no chromogenesis on agar or gelatin medua.
 A. Litmus milk turned alkaline. No acid from carbohydrates.

## Genus I. Alcaligenes, p. 412.

B. Latmus milk slightly acid (never curdled), unchanged or alkaline. Acid usually produced from hexose sugars.

## Genus II. Achromobacter, p. 417.

- Produces yellow to orange chromogenesis.
  - A Litmus milk slightly acid (never curdled) unchanged or alkaline Acid usually produced from hexose sugars.

# Genus III. Flavobacterium, p. 427.

Genus I. Alcaligenes Castellani and Chalmers.\*

(Manual Trop Med., 3rd ed., 1919, 936) From M.L., alkalı and Latin genio, to produce.

Peritrichous to monotrichous, or non-motile rods. Gram-negative to Gramvariable. Do not produce acid or gas from carbohydrstes. May or may not lquefy gelatin and solidified blood serum. Turn litmus milk alkaline and may or may not peptonize it Do not form acetylmethylearbinol. Chromogenesis when it occurs is grayish-yellow, brownish-yellow or yellow. Generally occur in the intestinal tract of vertebrates or in dairy products.

The type species is Alcaligenes faccalis Castellani and Chalmers.

<sup>\*</sup> Revised by Prof. H. J. Conn, New York State Experiment Station, Geneva, New York, June, 1938; further revision by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, June, 1945.

#### Key to the species of genus Alcaligenes.

- I. Celatin not liquefied.
  - A. Motile.
    - Does not produce repiness in milk. Found in the intestinal tract.
       Alcaligenes faccalis.
      - 2. Produces ropiness in milk
    - B. Non-matile.
      - 1. Found in the intestinal tract
- 2 Alcaligenes viscosus.
- 3 Alcaligenes metalcaligenes.
- II Gelatin liquefied.
  - A Motile.
    - 1. Milk peptonized; blood serum liquefied.
    - 4 Alcaligenes bookeri.
      2 Milk not peptonized, blood serum not liquefied.
  - B. Non-motile.
    - I Milk peptonized, slimy
- 5 Alcaligenes recti.

  6. Alcaligenes marshallis.
- 1 Alcaligenes faecalis Castellanı and Chalmers (Bacillus faecalis alcaligenes Petruschky, Cent f Bakt , I Abt , 19, 1896, 187; Bactersum fecalis alcalig. enes Chester, Ann Rept Del Col Agr Exp. Sta., 9, 1897, 73; Bactersum alcalig. enes Lehmann and Neumann, Bakt Diag , 2 Aufl , 1899, 212; Bacillus alcaligenes Migula, Syst. d. Bakt., 2, 1900, 737, Castellani and Chalmers, Manual Trop Med., 1919, 936; Bacillus fecalis-alcaligenes Holland, Jour. Baet , 5, 1920, 218, Bactersum fecalis-alcaligenes Holland, ibid; Vibrio alcaligenes Lehmann and Neumann, Bakt. Diag., 7 Aufl , 2, 1927, 518 Bacterium faecale alcaligenes Monias, Jour Inf. Dis . 45, 1928, 330.) From Latin facz, dregs; M. L. fecal
- Rods 0.5 by 1.0 to 2.0 merons, occurring singly and in pairs, and occasionally in long chains. Mottle with pertiribous fagells. In some strains, the majority of the individual cells show only a single flagellum. This is ant to be in a lateral rather than in the polar position. Gumneyative
- Gelatin colonies. Circular, grayish. translucent.

Gelatin stab: Gmy surface growth. No liquefaction.

Agar colonies: Transparent with opaque center, undulate margin. Agar slant: White, glistoping, opales-

Agar stant: White, glistoning, opalescent, undulate margin

Broth Turbid, with thin pellicle, and viscid sediment. Gives off ammonia Litmus milk Alkaline.

Potato: Scanty to abundant, yellowish to brownish growth.

Indole not formed.

Nitrate production from natrates vari-

No acid or gas from carbohydrate media

No characteristic odor

Aerobie, facultative. Optimum temperature 37°C

Source Feees, abscesses related to intestinal tract, occasionally blood

stream
Habitat: Intestinal canal Generally
considered non pathogenic

la. Alcaligenes faccalis var radicans Evans (Public Health Rots., 46, 1931, 1676) is a gelstin houefying strain

2. Alcaligenes viscosus (Weldia and Levine) Weldin. (Bacillus lactis viscosus Adametz, Cent f. Bakt., 9, 1891, 698; Bacillus viscosus lactis Kruse, in Flügge, Die Mikroorganismen, 2, 1896, 359; Bacterium viscosus lactis Chester, Delaware Agr. Exp Sta. 9th Ann. Rept., 1897, 89; Bacterium lactis viscosum Lehmaun and Neumann, Bakt. Diag., I Aufl., 2, 1896, 198 (Eng. ed , 1901, 196); Bacterium subviscosum Migula, Syst. d Bakt., 2, 1900, 326; Group I, varieties 1, 2, 3, 4 and 5 of Harrison, Rev Gen du Lait, 5, 1905, 100; Bacterium visco-coccoidium Buchanan and Hammer, Iowa Agr. Exp. Stat. Research Bull. 22, 1915, 260; Bacillus lactisviscosus Holland, Jour. Bact., 5, 1920, 218; Bacterium lactis viscosus Holland, idem; Bacterium viscosum Weldin and Levine. Abst. Bact , 7, 1923, 16 (not Bacterium viscosum Migula, Syst d. Bakt., 2, 1900, 647), Lactobacıllus viscosus Bergey et al , Manual, 1st ed , 1923, 244; Achromobacter viscosum Bergey et al , Manual, 2nd ed., 1925, 169; Weldin, Iowa State College Jour. Sei , 1, 1927, 186 ) From Latin viscosus, viscous.

Description taken largely from Long and Hammer, Iowa State Coll. Jour. of

Sei , 10, 1936, 262.

Rods 06 to 10 by 08 to 2.6 microns, almost spherical cells frequently found, occurring singly, in pairs or short chains. Motile (Adametz, loc. cit.), non-motile (Long and Hammer, loc. cit.). Gramnegative, rarely Gram-positive Capsules produced in milk cultures

Gelatin colonies Small, gray becoming vellowish

J CHOWISI

Gelatin stab White surface growth with villous growth in stab. No lique-faction.

Agar colonies. After 3 to 4 days, circular, 4 to 6 mm in diameter, white, viscid, shining, edge entire.

Agar slant Abundant, white, spread-

ing, viscid, shining

Broth: Turbid with thin pellicle and some sediment Ropiness generally produced. Litmus milk: Ropiness produced. Pellicle formed. Alkaline. No coagulation Potato: Moderately heavy, dirty-white,

spreading, shining growth.
Indole not formed.

Nitrites ordinarily not produced or produced only in a trace from nitrates

No H2S produced.

Slight, if any, acid production from carbohydrates.

Fat is hydrolyzed.

Methyl red reaction negative

Voges-Proskauer reaction negative. Temperature relations: Growth occurs at 10° and at 20°C. At 37° and at 40°C

growth variable.
Acrobic

Aerobic

Source: Originally isolated from water Habitat: Found in water and around dairy barns, dairy utensils. Produces ropiness in milk.

Long and Hammer (Iowa State Coll Jour. Sci., 10, 1936, 264) have described a variety of this species (Alcaligents viccosus var. dissimilis) which does not produce repiness in milk.

3. Alcaligenes metalcaligenes Castellani and Chalmers. (Castellani and Chalmers, Man. Trop. Med., 1919, 98). Bacterium metalcaligenes Weldin and Levine, Abst. Bact., 7, 1923, 13; Action mobacter metalcaligenes Bergey et st. Manual, 2nd ed., 1925, 169.) From Greek meta, in common with; M. L., resembling alcaligenes.

Rods. 0.6 by 1.5 microns, with rounded ends, occurring singly and in pairs. Nonmotile. Gram-negative.

Gelatin stab: No liquefaction.

Agar colonies: Circular, raised, smooth, amorphous, entire, gray.

Agar slant: Gray, scanty, filiform, contoured, viscid.

Broth: Membranous pellicle with heavy sedument.

Litmus milk: Alkaline.

Potato: Scanty, glistening, smooth, sometimes faint pink.

Indole not formed.

Nitrite production from nitrates variable.

Starch not hydrolyzed.

Blood scrum not liquefied. No action on carbohydrates.

Aerobic, facultative

Optimum temperature 22°C Habitat · Intestinal canal

4. Alcaligenes bookerl (Ford) Bergey et al (Bacillus A of Booker, Trans Ninth Internat, Med. Congress, 5, 1887, 598. Bacillus bookers Ford. Studies from the Royal Victoria Hospital, Montreal, 1. 1903, 31; Bergey et al , Manual, 1st ed , 1923, 236, Bacterium booker: Levine and Soppeland, Eng Exp Sta , Iowa State College, Bul. 77, 1926, 55 ) Named for

the bacteriologist who first isolated this species Rods . 0 5 by 1.5 to 2 0 microns, occurring singly Motile with peritrichous

flagella. Gram-negative Gelatin colonies: Circular, brown,

variable ın sıze

Gelatin stab. Slow, seccate liquefaction, becoming stratiform

Agar colonies . Thin, transparent, with opaque center and indistinct margin

Agar slant . Abundant , vellowish to yellowish-brown

Broth Turbid, with viscid sediment No pellicle.

Litmus milk: Alkaline. Soft curd Litmus reduced Peptonization Potato Luxuriant, yellowish-white,

moist. Medium is darkened

Indole not formed.

Natrites not produced from nitrates No acid or gas from carbohydrate media

Blood serum Yellowish-brown growth Gradual liquefaction

No characteristic odor

Aerobic, facultative.

Optimum temperature 37°C Source: From alvine discharges of chil-

dren suffering with cholers infantum

Habitat : Intestinal canal.

5. Alcaligenes recti (Ford) Bergev et al. (Bactersum recti Ford, Studies from the Royal Victoria Hospital, Montreal, 1, 1903, 31; Bergey et al , Manual, 1st ed., 1923, 236 ) From Latin rectus, rectum

Rods: 05 by 15 to 20 microns, occurring singly, in pairs and in chains. Motile with pentrichous flagella Gramnegative.

Gelatin colonies Variable in size and shape, circular to oval, brown,

Gelatin stab; Rapid, saccate liquefac-

Agar colonies. Large, grayish-white, with opaque center. Slightly spreading Agar slant Grayish-white, echinulate.

Broth. Turbid No pellicle. Litmus milk Alkaline. No peptoniza-

Potato Luxuriant, moist, brownish-

red.

Indole not formed Natrates produced from natrates.

No acid or gas from carbohydrate media. Blood scrum Abundant white growth. No hauefaction

No characteristic odor

Acrobic, facultative.

Optimum tempemture 37°C Source Found but once from coccum and rectum (Ford).

Habitat Intestinal canal

6 Alcaligenes marshallil Bergev et al (Bacillus B of Marshall, Cent f Bakt., II Abt . II. 1903, 739, Bacterium lactis marshall: Conn. Esten and Stocking, Ann Rept Storrs Agr Exp Station, 1906, 141. Bergey et al , Manual, 1st ed , 1923, 237 ) Named for Prof. C. F. Marshall, the American bacteriologist who first isolated this apecies

Rods 03 by 12 mierons, occurring singly. Non-motile Grain-negative Gelatin colonies Gray, granular, ir-

regular, glistening

Gelatin stab Slow, infundibuliform liquefaction

Agar slant Filiform, gray to ereamy. white, raised, becoming lemon-yellow.

Broth: Turbid, with gray ring and viscid sediment.

Litmus milk: Alkalinė, slimy, peptonized, strong odor.

Potato: Luxuriant, lemon-yellow, smooth.

Indole not formed.

Nitrites not produced from nitrates. No neid or gas from carbohydrates. Acrobic, facultative.

Optimum temperature 30°C.
Habitat: Milk.

Appendix: The following species have also sometimes been regarded as belonging in the genus Alcaligenes, or possess characters that indicate that they belong in this genus.

Acknomobacter alcaliaromaticum (Berlin) Borgey et al. (Bacterium alcaliaromaticum Berlin, Rev. de Mierobiol. et Epidemiol., 6, 1927; Bergey et al., Manual, 3rd ed., 1930, 212.) From feces. See Manual, 5th ed., 1939, 509 for a description of this species This species is much like Alcaliagnes faccalis

Achromobacter cystinocorum Barber and Burrows. (Biochom. Jour, 30, 1936, 599) From soil See Manual, 5th ed., 1939, 516 for a description of this species. Thus species is much like Alcaligenes marshalli.

Achromobacter lipidis (Anderson) Allison, Anderson and Cole. (Bacter-tum lipidis Anderson, Internat. Assoc. Milk Dealers, Proc. 30th Ann. Convention, Labora ory Section, October, 1937, 19; Allison, Anderson and Cole, Jour. Bact., 58, 1938, 571.) From rancid cream. See Manual, 5th ed., 1934, 522 for a description of this species This species is much like Alcaligenes metal-catioenes.

Alcaligenes albus Bergey et al. (Bacterum lactis album Conn. Esten, and Stocking, Ann. Rept, Storrs Agr. Exp Station, 1908, 143; Bergey et al., Maoual, let ed., 1923, 237.) From udder of cow. Gram-positive. See Manual, 5th ed., 1939, 190 for a description of this species.

Alcaligenes alcalinofoetidus Hauduroy et al. (Bacillus alcalinofoetidus Castellani, Jour. Trop. Med., 1930, 134; Hauduroy, Ehringer, Urbain, Guillot and Magrou, Dictionnaire des bactéries pathogènes. Paris, 1937, 29.) From tonsils of persons having an offensive breath.

Alcaligenes ammoniagenes (Cooke and Keith) Bergey et al. (Bacterium ammoniagenes Cooke and Keith, Jour. Bat, 13, 1927, 315; Bergey et al., Manual, 3rd ed., 1930, 367.) From feces of infants. Gram-positive. See Manual, 5th ed., 1939, 99 for a description of this species.

Alcoligenes denieri Corbet. (Organism No. 6, Denier and Vernet, Le Ceoulchoue, 17, 1920, 10193; Quart. Jour Rubber Research Inst., Malaya, 2, 1930, 182) From the latex of Herea brankensis (para rubber tree). Gram-positive. See Manual, 5th ed., 1939, 99, for a description of this species.

Alcaligenes faccalis var mariense Havduroy et al. (Bacillus mariense Klimenloquoted from Besson, Technique Microbiologique, p. 904; Hauduroy et al., Dict-Path. Bact., Paris, 1937, 31.) A hydrogen sulfide producing variety.

Alcaligencs lenis De Assis. (Boletin do Inst. Vital Brasil, Niteroi, No 13, 1930, 1.) From human blood stream. Alcaligence sterensee Brown. (Amer

Museum Novit., No. 251, 1927, 5.)
From crushed egg masses of the moth
(Malacosoma americana). Said to be
related to Alcaligenes bronchssepticus
Bacillus coeci Ford. (Ford. Studies

from Royal Victoria Hosp, Montreal, I, No. 5, 1903, 45.) Found in stomach and rectum of a single human subject. Much like Alcaligenes bookeri.

Bacillus pylori Ford. (Ford, Studies from Royal Victoria Hosp, Montreal I, No. 5, 1903, 44.) Found in the human stomach. Liquefied gelatin and peptooized casein but did not liquefy blood serum.

Flavobacterium fecale Bergey et al. (Bacillus fecale aromalicum Stuter, Cent. f. Bakt., I Abt., Orig, 91, 1923, 67; Bergey et al., Manual, 3rd ed., 1930, 150) From fecos. Resembles Alcalgenes marshallus. See Manual, 5th ed., 1939, 515 for a description of this species.

#### Genus II. Achromobacter Bergen et al. \*

(Bergey et al., Manual, 1st ed. 1923, 132; Achromobacterium Richards, Proc. Soc. Agr. Bact. (British), 15th Ann. Conf., 1944, 14.) From Greek achroma, without color and bactrum, a staff or rod

Non-pigment-forming (at most no pigment formed on agar or gelatin) rods. Motile with peritrichous flacella or non-mottle. Gram-negative to Gram-variable. Litmus milk faintly acid to unchanged or alkaline. Occur in salt to fresh water and in soil.

The type species is Achromobacter liquefactens (Eisenberg) Bergey et al. Key to the species of genus Achromobacter.

# I. Motile. Flagella peritrichous

#### A. Gelatin liquefied

- 1. Litmus milk unchanged.
  - a. Nitrites not produced from nitrates.
    - 1. Achromobacter liquefaciens.
  - aa. Nitrites are produced from nitrates.
    - 2. Achromobacter thalassius. 3. Achromobacter 10phagum.
- 2. Litmus milk acid.
  - a Natrites are produced from nitrates.
  - 4 Achromobacter delicatulum.
- B. Gelatin not liquefied
  - 1. Litmus milk unchanged.
    - a. Nitrites are produced from nitrates.
      - 5. Achromobacter aquamarınus.
  - 6. Achromobacter cuclociastes. 2. Litmus milk slightly acid
    - a. Nitrites not produced from nitrates.
      - 7. Achromobacter superficiale.

#### II. Non-motile.

- A. Gelatin liquefied
  - 1. Litmus milk unchanged
    - a. Nitrites slowly produced from nitrates 8 Achromobacter stenohalis.
    - as. Nitrites not produced from nitrates.
      - 9. Achromobacter butura.
    - 2. Litmus milk alkaline
      - a Nitrites are produced from nitrates 10 Achromobacter stationss.
- B. Gelatin not liquefied.
  - 1. Litmus milk unchanged.
    - a. Action on nitrates not recorded 11 Achromobacter eurudice.
  - 2. Litmus milk acid, reduced in 5 days.
    - a Nitrites are produced from nitrates. 12 Achromobacter delmarrac.

<sup>·</sup> Partially rearranged before his death by Prof D. H. Bergey, Philadelphia, Penn. sylvania, September, 1937, further revision by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, August, 1945.

Achromobacter liquefaciens (Eisenberg) Bergey et al. (Bacillus liquefaciens Eisenberg, Baht. Diag., 3 Aufl., 1891, 112; not Bacillus liquefaciens Doyen, Jour. d. connaiss médic., 1859, 103; not Bacillus liquefaciens Lucet, Ann. Inst. Past., 7, 1893, 327; not Bacillus liquefaciens Migula, Syst. d. Bakt., 2, 1900, 723; Bacillus sternbergii Migula, Syst. d. Bakt., 2, 1900, 726; Bergey et al., Manual, 1st ed., 1923, 135.) From Latin, liquefying.

Description emended by Bergey et al. (loc. cit.). This is reported to be a common water organism by Lustig (Ding d. Bakt. des Wassers, 1803, 86), by Frankland and Frankland (Microorganisms in Water, 1804, 461) and by Horocks (Bact. Evam. of Water, 1901, 54).

Short, rather thick rods, with rounded ends, occurring singly. Motile, possessing peritrichous flagella. Grom-negative.

Gelatin colonies: Circular, gray, entire, slimy. Liquefaction. In time a putrid odor.

Gelatin stab: Napiform liquefaction.

Agar slant: Dirty-white, spreading growth.

Broth : Turbid.

Litmus milk: Unchanged.

Potato: Light yellow streak.

Indole not formed.

Nitrates not produced from natrates. Aerobic, facultative

Optimum temperature 20° to 25°C. Habitat: Water.

 Achromohacter thalassius ZoBell and Upham. (Bull Scripps Inst. of Oceanography, Univ. Calif., δ, 1944, 279.)
 From Greek thalassius, marine, of the sca

Rods: 0 6 to 0.7 by 0 8 to 2.3 microns, with some variation in shape, occurring singly, in pairs and short chains and many cells lying side by side. Motile by means of pertirichous flagella. Gram-negative but cell walls tend to retain stain.

All media except the fresh-water broth,

litmus milk, and potato were prepared with sea water.

Gelatin colonies: 1 mm, circular, white.

Gelatin stab: Napiform liquefaction. Filiform growth along line of stab.

Agar colonies: Punctiform, rough, translucent, raised.

Agar slant: Moderate, glistening, beaded, watery, butyrous growth with no pigment.

Sen-water broth: No pellicle, slight turbidity, scanty powdery sediment.

Fresh-water broth: Fair growth.

Litmus milk: No visible change.

Litmus milk: No visible change Casein not digested.

Potato: No visible growth.

Indole not formed.

Nitrites are produced from nitrates.

Does not ferment glucose, lactose, maltose, sucrose, xylose, mannitol, glycerol,

or saliein. Starch not hydrolyzed.

Hydrogen sulfide not formed.

Ammonia produced from peptone but

not from urea.

Fats not hydrolyzed.

Acrobic, facultative. Optimum temperature 20° to 25°C Source: Marine bottom deposits.

3. Achromobacter iophagum (Gray and Thornton) Bergey et al. (Bacterium tophagum Gray and Thornton, Cent i. Bakt., 11 Abt., 73, 1928, 59; Bergey et al., Manual, 3rd ed., 1930, 201) From Greek ius, a poison and phagein, to est or devour.

Rods: 0.8 to 1.0 by 10 to 5.0 microns. Mottle by means of peritrichous flagella. Gram-negative.

Gelatin colonies: Quickly liquefied

Gelatin stab: Liquefied.

Agar colonies: Circular or amochoid, whitish, flat, raised, smooth, translucent,

Agar slant . Filiform, white to buff, flat, undulate.

Broth: Turbid.

Litmus milk: Unchanged.

Nitrites produced from nitrates Starch hydrolyzed.

Acid from glucose and sucrose. Occasionally from maltose and glycerol

Attacks phenol and asphthalene Aerobic, facultative

Optimum temperature 30° to 35°G Source: Fifteen cultures from soil Habitat: Soil,

4. Achromobacter delicatulum (Jordan) Bergoy et al. (Bazillus delicatulus Jordan, Report Mass, State Bd of Health, 1890, 837, Bacterium delicatulus Chenter, Ann. Rept. Del. Col Agr Exp Sta., 9, 1897, 82; Bergoy et al., Manual, 1sted , 1923, 1377. From Latin delicatus, soft, delicato; M. L. delicatulus, somewhat delicate.

Gharacters added to Jordan's description by Bergey (loc. et ) from his private notes are indicated. Steinhaus (Jour-Bact., 42, 1941, 771) apparently found the same organism and has added other characters.

Rods: 10 by 20 microns, occurring singly (Jordan). Motile, possessing perttrichous flagella. Gram-negative (Bergey).

Gelatin colonies. Whitish, homogene-

ous, with radiate margin
Gelatin stab. Infundibuliform lique-

faction.
Agar slant: Whitish, glistening.

Agar siant: Whitish, glistening.
Broth: Turbid, with gray pelliele and sediment.

Litmus milk. Acid. Slow reduction and peptonization (Steinhaus)

Potato: Thin, gray streak Acid from glucose, sucrose, maltose and

lactose (slow) (Steinhaus).
No hydrolysis of starch (Steinhaus).

No H2S produced (Steinhaus) Indole not formed (Bergey).

Nitrites produced from nitrates.

Aerobic, facultative. Optimum temperature 30° to 35°C.

Optimum temperature 30° to 35°C. Source: From the effluent of a septic tank (Jordan). From water (Bergey) From the alimentary tract of an adult Colorado potato beetle (Leptinotarsa decembraca Say) (Steinhaus).

Habitat: Presumably widely distributed in nature.

5 Achromobacter aquamarinus ZoBell and Upham. (Bull. Scripps Inst of Oceanography, Univ. Calif., δ, 1944, 264.) From Latin aqua, water, and marinus,

Rods 08 by 1.2 to 20 microns, with rounded ends, occurring singly. Motile by means of a few peritrichous flagella. Gram-negative.

All media except the fresh-water broth, litmus milk, and potato were prepared with sea water

with sea water
Gelatin colonies. 2 mm, convex, circu-

lar, entire, whitish.

Gelatin stab Poor growth, no lique-

faction, no pigment.

Agar colonies: 2 mm, convex, smooth, circular

Agar slant: Moderate, beaded, glisten-

ing, butyrous growth with no pigment. Sea water broth. Surface ring, moderate turbidity, heavy viscous aediment.

Fresh-water broth: Poor growth.

Litmus milk. No visible change.

Casein not digested

Potato. No visible growth.

Indole not formed.

Nitrates rapidly produced from hitrates.

Produces acid but no gas from glucose and maltose Does not ferment lactose, sucrose, mannitol, glycerol, xylose, or sulicin

Starch not hydrolyzed

Hydrogen sulfide not formed Ammonia produced from peptone but not from urea.

Fats are hydrolyzed.

Aerobic, facultative.

Optimum temperature 20° to 25°C.

Source: Found in sea water and on submerged slides.

Habitat: Sca water.

6. Achromobacter cyclocisstes (Gray and Thornton) Bergey et al. (Bacterium cycloclastes Gray and Thornton, Cent. f. Bakt., II Abt., 73, 1928, 89; Bergey et al., Manual, 3rd ed., 1930, 212.) From Greek cyclus, ring and clastus, breaking in pieces.

Rods: 1.0 to 1.5 by 1.5 to 8.0 microns. Motile with 1 to 12 peritrichous flagella.

Gram-negative.

Gelatin colonies: Circular, white, raised, smooth, glistening, entire. Gelatin stah · No liquefaction. Nail

head growth.

Agar eolonies: Circular to amochoid. white, flat to convex, smooth, glistening, translucent with opaque ceoter, entire.

Agar slant: Filiform, pale buff, raised, smooth, glistening, undulate.

Broth: Turbid.

Natrites produced from nitrates.

Starch not hydrolyzed.

Litmus milk unchanged. No acid from carbohydrate media.

Attacks phenol and naphthalene. Aerobie, facultative.

Optimum temperature 30° to 35°C. Source: Three cultures from soil.

Habitat : Soil.

7. Achromobacter superficiale (Jordan) Bergey et al. (Bocillus superficiolis Jordan, Report Mass. State Bd. of Health, 1890, 833; Bocterium superficialis Chester, Ann. Rept. Del. Col. Agr. Exp. Sta , 9, 1897, 94; Bergey et al , Manual, 1st ed., 1923, 144.) From Latin superficialis, lying on the surface.

Characters added to Jordan's description by Bergey (loc. cit.) from his private

notes are indicated.

Rods: 1.0 by 2.2 microns, occurring singly (Jordan). Motile, possessing peritrichous flagella. Gram-negative (Bergey).

Gelatin colonies · Small, circular, gray, translucent

Gelatin stab: Scanty surface growth. Slow liquefaction.

Agar slant: Limited, gray, filiform. Broth: Slightly turbid.

Litmus milk: No change. Later hecoming slightly acid.

Potato: No growth (Jordan). Limited growth (Bergey). Ahundant (Steinhaus),

Indole not formed (Bergey).

Nitrites not produced from nitrates. Aerobie, facultative.

Optimum temperature 25° to 30°C.

Source: Sewage. Gibbons (Contrib. to Canadian Biol. and Fish., 8, No. 22, 1934, 279) reports this species as occurring in the slime and feces of the cod (Godus collarias) and dogfish (Squalus acanthias). An organism apparently identical with this organism has been found by Steinhaus (Jour. Baet., 42, 1944, 771) io the intestines of beetle larvae (Urographus fasciota DeG.).

Habitat: Presumably widely distributed in nature.

8. Achromohacter stenohalis ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 257.) From Greek stenus, narrow or close, and holinus, salty; adapted to a slight change of salinity only.

Rods: 08 to 0.9 by 0.8 to 1.6 micmas, occurring singly, in pairs and short ebains. Non-motile. Capsulated. Gram-negative.

All media except the fresh-water broth, litmus milk, and potato were prepared with sea water.

Gelatin colonies: 1 mm, whitish, circular, convex, entire. No pigment.

Gelatin stab Very slow crateriform liquefaction. Napiform in 50 days.

Agar colonies: Small, circular, opalescent, lobate edge, convex with slightly

raised margin, smooth. Agar slant: Moderate, beaded, glistening, opalescent, beaded growth with no pigment.

Sea-water broth: Moderate turbidity, viscid sediment, no pellicle or ring.

Fresh-water broth: No visible growth Litmus milk: No visible change

Casein not digested. Potato: Na visible growth. Indole not produced.

Nitrites slowly produced from nitrates No acid or gas from glucose, lactose, maltose, sucrose, mannitol, glycerol, xylose, or salicin.

Starch not hydrolyzed.

Hydrogen sulfide not produced.

Ammonia produced from peptone but
not from urea.

Fats are not hydrolyzed.

Aerobic, facultative (poor anaerobic growth)

Optimum temperature 20° to 25°C Source. Sea water, marine mud, and marine phytoplankton.

Habitat : Sea water

Achromohacter butyri Bergey et al (Microsceus butyri-aroma@czens Kelth, The Technology Quarterly, 10, 1807, 247; Bacillus butyri aroma@czens Grimm, Cent. F. Bakt, 11 Abt, 8, 1902, 591; Bergey et sl, Manual, 1st ed, 1902, 145; Becterum butyraroma@czens Omeliansky, Jour. Bact., 8, 1923, 400)

Rods: 0 5 to 1 0 micron, nearly spherical, occurring singly and in pairs Non-

motile. Gram-negativs

Gelatin colonies White, circular, smooth, glistening. Gelatin stab: White surface growth,

liquefaction with white sediment Agar slant · Abundant, white, glisten-

Agar slant · Abundant, white, gristen-

Broth: Turbid, with ring and sediment.

Litmus milk: Reaction unchanged

Aromatic odor.

Potato: Slow and limited, white growth.

Nitrites not produced from natrates.
Aerobie, Incultative.

Optimum temperature 25°C.

Habitat: Milk.

10 Achromobacter stationis ZoBell and Upham. (Bull. Scripps Inst. of Occanography, Univ. Calif , 5, 1911, 273) From Latin statio, anchorage. Ovoid rods: 0.4 by 0.5 to 0.6 microns, occurring singly or in chains of two to three Non-motile. Gram-positive but easily destained.

All media except the fresh-water broth, litmus milk, and potato were prepared with sea water.

Gelatin colonies: 0 5 to 1 mm, circular, convex, gravish-white.

Gelatin stah: Very slow papiform

liquefaction.

Agar colonies: 1 to 2 mm, convey,

lobate edge, smooth, colorless.

Agar slant: Moderate, glistening, fili-

form, hutyrous growth with no pigment. Sea-water hroth Heavy pellicle, no turbidity, granular growth along walls, scanty sediment

Fresh-water broth. Good growth.

Litmus milk: Becomes alkaline. Casein not digested.

Potato: No visible growth.

Indole not formed.

Nitrites rapidly produced from ni-

trates.
Produces acid but no gas from glucose.

Does not ferment lactoso, maltose, sucrose, mannitol, glycerol, xylose, or salicin.

Starch not hydrolyzed.

Hydrogen sulfide not formed.

Ammonia produced from peptone hut not from urea.

Fats not hydrolyzed.

Aerobic, facultative.

Optimum temperature 20° to 25°C. Source: Found in film of marine fouling oresnisms.

Habitat: Sea water.

11. Achromobacter eurydice (White) Bergey et al. (Bacterium eurydice White, U S. Dept. of Agr., Bur. of Entomol, Circ. 157, 1912, 3 and U. S. Dept. of Agr. Bull. 810, 1920, 15; Bergey et al, Manual, 2nd ed., 1925, 170.) From Greek Eurydice, the wife of Orpheus.

Rods: Small, slender, with slightly rounded ends, occurring singly and in pairs. Non-motile. Gram-negative Gelatin stab: A bluish-gray growth occurs along the line of inoculation. No liquefaction.

Glucose agar colonies: Bluish-gray, circular, smooth, glistening, entire.

Broth: Uniform turbidity with viscid sediment.

Litmus milk: Unchanged.

Acid from glucose but little or no action on other carbohydrates.

Potato: Slight, grayish growth.

Aerobic, facultative.

Innocuous when fed to bees. Not pathogenic when inoculated subcutaneously in rabbits.

Source. Occurs as a secondary invader in European foulbrood of bees

Habitat: Unknown.

12. Achromobacter delmarvae Smart (Smart, Jour. Bact., 25, 1932, 41 and Jour. Agr. Research, 51, 1935, 363.) From Delmarva, councd from Del., Mar and Va., the regions in which the species was found.

Short rods. Average size 0.75 by 1.5 microns, with rounded ends, occurring singly, in pairs and in short chains. Non-motile. Gram-negative

Gelatin colonies Similar to agai

Gelatin stab: Seanty growth. No

Beef-infusion agar colonies: Small, circular, raised, edges smooth, glistening, translucent, bluish-white, amorphous, margin entire

Agar stab Abundant growth Surface growth round, smooth, glistening, bluish-white, raised Fihform growth the whole length of stab, but growth best at top.

Agar slant Abundant filiform growth, raised, glistening, smooth, translucent, bluish-white, no odor; old cultures slightly viscid Medium unchanged.

Nutrient broth: Turbid. Delicate white pellicle. Sediment abundant, white, slightly stringy. No odor. Color of medium unchanged. Sterile milk: Slow growth. No peptonization. Coagulation in 12 to 14 days. Milk turns chocolate brown beginning at top.

Litmus milk: Acid with reduction of litmus in 5 days. Coagulation with return of pink color in 12 to 14 days. Browning of medium.

Potato: Abundant growth, grayishwhite, glustening, smooth, raised. Medium changed from white to smoke-gray. Indole not formed.

Nitrites produced from nitrates in 7

days at 26°C.

No H<sub>2</sub>S produced. Ammonia not formed.

Diastatic action weak.

Acid but no gas from glucose, lactose, glycerol and mannitol. Alkaline reaction and no gas from sucrose.

Optimum pH 70.

Temperature relations: Optimum 26°C. Good growth up to 31°C. Very slight growth at 37° and at -8°C.

Facultative anacrobe.
Source: Isolated from fresh strawberries from Delaware, Maryland and

Virginia. Habitat: Unknown.

Appendix: Many of the following species were described before Gram and flagella stains had been perfected Hence it is impossible to identify them definitely as belonging to Achromobacter. Comparative study is needed in other cases before the remaining species can be placed in their proper place in the genus.

Achromobacter acidum (Chester)
Bergey et al. (Species No. 56 of Conn.
Storrs Agr. Exper. Sta. 7th Ann Rept.
for 1894, 1895, 83; Bacterium acidum
Chester, Man. Determ. Bact., 1901,
146, Bergey et al., Manual, 1st ed., 1923,
151.) From milk. See Manual, 4th
dd., 1934, 246 for a description of this

organism

Achromobacter agile (Ampola and Garino) Bergey et al. (Bacillus dentitificans agilis Ampola and Garino, Cent.

f. Bakt., II Abt., 2, 1896, 673; Bacterium dentityficans agalie Chester, Ann. Rept Del Col Agr. Evp Sta., 9, 1897, 76, Bacterium agale II Jensen, Cent. T. Bakt., II Abt., 4, 1898, 408; Bactellus dentityficans Migula, Syst. d. Bakt., 2, 1900, 796, not Bactilus dentityficans Chester, Man Determ Bact., 1901, 274, Bactilus agaits Chester, Man Determ Bact., 1901, 226, not Bactilus agaits Techistowisch, Berl klin Wehnschr, 1892, 512, Bergey et al., Manual, 1st. ed., 1923, 138) From cow manure See Manual, 4th. ed., 1934, 219 for a description of this organism

Achromobacter album (Uisenberg) Bergoy et al. (Beacilus albus Iisenberg,
Bakt. Ding., 3 Aufl., 1891, 171. Bacterum
albus Chester, Ann Rept. Del. Col
Agr. Exp Sta., 9, 1897, 76, Beregve et al.,
Manusl, 1st ed., 1923, 141.) From
water Gibbons (Contrab. to Canadian
Biol and Fish, 8, No. 22, 1934, 279)
reports this species from the slame on
cod (Gadus callaras). See Manual,
4th ed., 1931, 222 for a description of this
organism

Achromobacter amylocorum (Rubentschick) Bergey et al (Urobacterium amylocarum Rubentschick, Cent f Bakt, II Abt, 64, 1925, 168, sbrd, 68, 1926, 161; Bergey et al, Manual, 3rd ed, 1930, 225. From sewage sime See Manual, 6th ed, 1939, 514 for a de-

scription of this organism.

Achromobacter anaerobium Shimwell. (Jour. Inst. Brewing, 43, 1937, 507)

From spoiled beer.

Achromobacter aromafacteras (Chester) Bergey et al. (Species No. 41 of Conn. Storts Agr. Exper Sta., 7th Ann. Rept. for 1801, 1805, 57. Bacterium connit. Migula, Syst. d. Bakt., 2, 1900, 440; not Bacterium connit. Chester, Man. Determ Bact., 1901, 140; Bacterium aromafacteras Chester, loc cit., 148; Bergey et al., Manual, 1st. ed., 1923, 151) From milk sent from Uruguay to Chesgo. World's Fair. See Manual, 5th ed., 1923, 519 for a description of this organism.

Achromobacter archeum Rusakowa and Butkewitsch. (Microbiology (Russian), 10, 1941, 137; abst. in Cent f. Bakt, II Abt, 105, 1942, 140) From sea water (Barents Sea).

Achromobacter condicans (Frankland and Frankland) Bergey et al (Bacultucandicans G and P. Frankland, Zischr I Hyg., 6, 1889, 397; Bacterium candicans Chester, Ann. Rept. Del. Col Agr. Evp. Sta. 9, 1897, 130; Bergey et al., Manual, lated, 1923, 149) From soil. See Manual, 5th ed., 1939, 520 for a description of this organism.

Achromobacter centropunctatum (Jensen) Bergey et al. (Bactrium centropunctatus H. Jensen, Cant. 5 Bakt., II Abt., 4, 1808, 410; Bactillus centropunctatus Chester, Man. Determ. Bact, 1901, 225, Bergey et al., Manual, 1st ed., 1923, 139) From cow manure. See Manual, 4th ed., 1934, 220 for a description of this organism.

Acknowlader coccoideum (Chester) Bergey et al (Species No. 16 of Conn., Stors Agr. Exper Sta., 6th Ann Rept. for 1893, 1894, 51; Bacterium coccoideum Chester, Jann. Determ Back., 1901, 147; Bergey et al., Manual, 1st ed., 1902, 182.) From ripening eream See Manual, 5th ed., 1909, 520 for a deveription of this organism.

Achtamobacter connii (Chester) Bergey et al. (Culture No. 55, Conn, Storrs Agr Exp. Sta., 7th Annual Rept. for 1894, 1895, 83, Bacterium connii Chester, Man. Determ. Bact., 1901, 146, Bergey et al., Manual, lat ed., 1923, 149.) From milk. See Manual, 4th ed., 1931, 213 for a description of this organism

Achronobacter dendriteum (Lustus)
Bergey et al (Hautilus dendriteus
Lustus, Dasquestea dei batteri delle
acque, Torno, 1890 and Dasquestik der
Bakterien des Wassers, 1897, 99; Baderuum dendriteus Chester, Ann. Rept
Del. Col Agr. Fup. Sin. 9, 1897, 103;
Bergey et al "Manual, 2nd ed., 1923, 156)
From water. See Manual, Sth. ed.,
1939, 501 for a description of this organism.

Achromobacter epsteinii Peshkov. (Peshkov, Jour. of Biology (Russian), 6, 1937, 1003.) From water of a earp

pond near Moscow.

Achromobacter fermentationis (Chester) Bergey et al. (Bacterium fermentationis Chester, Del. Agr. Exp. Sta. Rept. 1899, 53; Bergey et al., Manual, 1st ed., 1923, 152.) From soil. See Manual, 4th ed., 1934, 247 for a description of this organism In Chester, Man. Determ. Bact., 1901, 231 this is listed as a synonym of Bacillus foetidus-liquefaciens Tavel, Ueber Actiol, der Strumitis, Basel. 1892.

Achromobacter filefaciens (Jensen) Bergey et al. (Bacterium filefaciens H. Jensen, Cent. f Bakt., II Abt., 4, 1898, 401; Bergey et al , Manual, 1st ed., 1923, 153 ) From dust. See Manual, 4th ed., 1934, 247 for a description of this organism.

Achromobacter formosum (Ravenel) Bergey et al. (Bacillus formosus Ravenel, Memoirs Nat. Acad. Sei., 8, 1896. 12; not Bacillus formosus Bredemann and Heigener, Cent. f. Bakt., II Abt., 93, 1935, 101; Bacterium formosus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 91, Bergey et al., Manual, 1st ed , 1923, 136.) From soil, Gibbons (Contrib to Canadian Biol, and Fish , 8, No. 24, 1934, 308) reports this species from fillets of haddock (Melanogrammus aeglefinus). See Manual, 5th ed., 1939, 505 for a description of this organism.

Achromobacter galophilum Bergey et al. (Culture No. 27, Baranik-Pikowsky, Cent f. Bakt., II Abt , 70, 1927, 373; Bergey et al., Manual, 3rd ed., 1930, 223 ) From sea water See Manual, 5th ed., 1939, 514 for a description of this organism.

Achromobacter gasoformans (Eisenberg) Bergey et al. (Gasbildner Bacillus, Tils, Zeitschr. f. Hyg., 9, 1890, 315; Bacillus gasoformans Eisenberg, Bakt. Diagnostik, 1891, 107; Bacterium gasoformans Chester, Ann. Rept. Del. Col. Agr Exp. Sta , 9, 1897, 93; Bergey et

al., Manual, 1st ed., 1923, 137.) From water. See Manual, 5th ed., 1939, 503 for a description of this organism. Gas bubbles observed in plain gelatin stab.

Achromobacter geminum (Chester) Bergey et al. (Bacillus geminus minor Ravenel, Memoirs Nat Acad. Sci., 8, 1896, 28; Bacterium geminus minor Chester, Ann. Rept. Del. Col. Agr. Exp Sta., 9, 1897, 72; Bacillus geminus Chester, Man. Determ. Baet., 1901, 216; Bergey et al., Manual, 1st ed., 1923, 142.) From soil. See Manual, 5th ed., 1939, 508 for a description of this organism,

Achromobacter guttatum (Zimmer-. mann) Bergey et al. (Bacillus gut-Zimmermann, Bakt, Trink- u. Nutzwässer, Chemnitz, 1, 1890, 56; Bacterium guttatus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta , 9, 1897, 94; Bergey et al , Manual, 1st ed., 1923, 140.) From water. See Manual, 5th ed., 1939, 50S for a description of this organism.

Achromobacter halophilum Bergey et al. (Culture No. 36, Baranik-Pikowsky, Cent. f. Bakt., II Abt., 70, 1927, 373; Bergey et al., Manual, 3rd ed., 1930, 220) From sea water. See Manual, 5th ed , 1939, 513 for a description of this organism.

(Jensen) hartlebii Achromobacter Bergey et al. (Bacterium hartlebis II. Jensen, Cent. f Bakt., H Abt., 4, 1898, 449, Bacillus hartichii Chester, Man Determ. Bact., 1901, 226, Bergey et al , Manual, 1st ed , 1923, 139.) From soil. See Manual, 4th ed., 1934, 213 for a description of this organism.

Achromobacter hyalinum (Jordan) Bergey et nl. (Bacillus hyalinus Jordan, Report, Mass State Bd. of Health, 1890, 835; Bacterium hyalinus Chester, Ann. Rept Del. Col. Agr. Exp. Sta., 9, 1897, 95; Bergey et al , Manual, 1st ed., 1923, 138.) From sand in a septic tank. See Manual, 4th ed., 1934, 216 for a description of this organism Also reported by Hatcher (Jour Elisha Mitchell Sci. Soc.

55, 1939, 332) from the feees of a cockroach (Periplaneta americana) Litmus milk acid and coagulated. Gram-negative.

Achromobacter inunctum (Pohl) Bergey et al (Bacillus inunctus Pohl, Cent. f Bakt, 11, 1832, 143; Bacterium inunctus Chester, Ann Rept Del. Col. Agr Exp. Sta, 9, 1897, 94; Bergey et al, Manual, 1st ed., 1923, 141.) From water. See Manual, 4th ed., 1934, 221 for a description of this organism

Actromobacter lacticum Bergey et al (Kramer, Die Bakterologie der Landwirtschaft, 2, 1802, 24, Bergey et al., Manual, 1st ed, 1925, 152) From shray milk. See Manual, 5th ed., 1939, 519 for a description of this organism This appears to refer to Loeffier's shray milk bacillus, more correctly known as Bacterium pituitosum Migula

Achromobacter larvae (Stutzer and Wsorow) Bergey ot al (Enterobacillus larvae Stutzer and Wsorow, Cent f Bakt, II Abt, 77, 1927, 119, Bergey et al, Manual, 3rd ed, 1939, 227) From intestinal tract of normal and diseased caterpullars of winterwheat cutworm (Euzoa segetum). See Manual, 5the ed, 1939, 541 for a description of this organism.

Achromobacter Injustum (Frankland and Frankland) Bergey et al. (Bacillus liquidus G and P. Frankland, Ztechr I. llyg. 6, 1859, 382, Bacterium liquidum Chester, Ann. Rept. Del Col. Agr. Exp. Sta. 9, 1837, 137, Pseudomonas liquida Chester, Man Determ Bact, 1901, 311, Bergey et al., Manual, 1st ed., 1923, 145) From water See Manual, 1st ed., 1923, 511 for a description of this organism Achromobacter litorale (Russell)

Bergey et al. (Bacillus literativ Russell, Zuschr f Hyg. 11, 1891, 199; Bacterium literalis Chester, Ann. Hept Del Col Agr Lyp Sta. 9, 1897, 91, Pseudomonas literatis Migula, Syst. d. Bakt. 2, 1903, 570, Bergey et al. Manual, 1st ed., 1923, 138) Nec Manual, 5th ed., 1979, 503 for a description of this organism. From mul bottom, Gulf of Naples. Achromobacter literale var. 2, Bois and Roy. (Naturaliste Canadien, 71, 1945, 259.) Frora intestine of the codfish (Gadus callarias L.).

Achromobacter middlelownii (Chester) Bergey et al. (Species No. 63 of Conn, Storrs Agr. Exper. Sta., 7th Ann. Rept. for 1894, 1895, 82; Bacterium middlelowni Chester, Man. Determ Bact., 1904, 147, Bergey et al., Manual, 1st ed., 1923, 151) From milk See Manual, 4th ed., 1934, 245 for a description of this organism.

Achromobacter mucidus Alford and McCleskey (Proc Louissana Acad Sci., 7, 1943, 25) From erab meat having musty odor.

Achromobacter nyibetsus Takeda. (Cent. f Bakt., II Abt., 94, 1936, 48.) From fish hatchery water. Not pathogenic to salmon eggs.

Achromobacter instrouorum (Jensen) Bergoy et al. (Bacterium introtorum H Jensen, Cent f. Bakt., II Abt., 4, 1808, 450, Bergey et al, Manual, 1st ed, 1923, 154) From horse manure See Manual, 4th ed, 1934, 213 for a description of this organism.

Achromobacter perotens Turner. (Australian Jour. Exp. Biol. and Med. Sci., 4, 1927, 57) From musty eggs

Achromobacter pestifer (Frankland and Frankland) Bergey et al. (Bacillus pestifer G. and P. Frankland, Philosoph Trans Roy. Soc. London, B. 178, 1888, 277, Bacterium pestifer Chester, Ann. Hept Del. Col. Agr. Evp. Sta., 2, 1807, 96, Bergey et al., Manual, 1st ed., 1923, 140) From dust. See Manual, 5th ed., 1939, 507 for a description of this organism

Achromobacter piloussky Bergey et al. (Culture No. 25, Baranik-Pikonsky, Cent f Bakt, II Abt., 70, 1927, 373; Bergey et al, Manual, 3rd ed., 1930, 222) Fram sea water Seo Manual, 5th ed., 1939, 514 for a description of this organism

Achromobacter pinnatum (Ravenel) Bergey et al. (Bacillus pinnatus Ravenel, Memoirs Nat. Acad. Sci., 8, 1896, 32; Bacterium pinnatus Chester, Ann. Rept. Del. Col. Agr. Evp. Sta., 9, 1897, 72, Bergey et al., Manual, lat ed., 1923, 142). From soil. S.e Manual, 4th ed., 1934, 223 for a description of this organism.

Achromobacter racenelii Bergey et al. (Bacillus geminus major Ravenel, Memoirs Nat Acad. Sci., 8, 1896, 27; Bacillus raceneli Chester, Man. Determ. Bact., 1901, 217; Bergey et al., Manual, 1st ed., 1923, 143.) From soil. Gibbons (Contrib. to Canadian Biol. and Fish., 8, No. 22, 1934, 279) reports this species from the slime on cod (Gadus callarias). See Manual, 4th ed., 1934, 224 for a description of this oreanism.

Achromobacter refractans (Wright) Bergey et al (Bacillus refractans Wright, Mem Nat. Acad. Sci. 7, 1894, 442; Bactersum refractans Chester, Ann. Rept. Del. Col. Agr. Evp. Sta., 9, 1897, 82; Bergey et al , Maoual, 1st ed., 1923, 150.) From water. See Manual, 4th ed., 1934, 244 for a description of this organism

Achromobacier reticulare (Jordan)
Bergey et al. (Bacillus reticulars)
Jordan, Rept. Mass. State Bd of Health,
1890, 834; Bergey et al., Manual, 1st
ed. 1923, 144) From the effluent of a
septie tank. See Manual, 5th ed., 1939,
510 for a description of this organism.

Achromobacter rodonatum (Ravenel) Bergey et al. (Bacillus rodonatus Ravenel, Memoirs Nat. Acad Sci, 8, 1896, 40; Bacterium rodonatus Chester, Ann. Rept Del Col Agr Evp. Sta., 9, 1897, 83, Bergey et al., Manual, ist ed., 1923, 150 ) From soil. See Manual, 4th ed., 1934, 244 for a description of this oreanism.

Achromobacter rugosum (Chester) Bergey et al (Species No 27, Conn, Storrs Agr Exp. Sta., 1893, 54, Bacıllus rugosus Chester, Man. Determ. Bact., 1901, 229; not Bacterum rugosum Henrici, Arb Bakt. Inst. Tech. Hochschule Karlsruhe, 1, 1834, 43; not Bacillus rugosus Wright, Memoirs Nat Acad. Sci., 7, 1895, 438; Bacterium geminus major Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 73; Bergey et al., Manual, 1st ed., 1923, 143.) From soil. See Manual, 4th ed., 1934, 224 for a description of this organism.

Achromobacter sewerinii Bergey et al. (Kultur No. 3, Sewerin, Cent. f. Bakt, II Abt., f. 1895, 162; Vibrio denitrificans Sewerin, Cent. f. Bakt., II Abt., 3, 1897, 517; Bergey et al., Manual, 1st ed., 1923, 140.) From horse manure.

Achromobacter solutarium (Ravenel)
Bergoy et al. (Bacillus solutarius Ravenel, Memoirs Nat. Acad. Sci. 8, 1895, 29;
Bacterium solutarius Chester, Ann. Rept
Del. Col. Agr. Exp. Sts., 9, 1897, 71,
Bergoy et al., Manual, 1st ed., 1923, 143.)
From soil. Gibbons (Contrib. to Canadian Biol. and Fish., 8, No. 22, 1931, 279)
reports this species from the alime on cod
(Gadus callarias). See Maoual, 5th ed., 1939, 509 for a description of this orcanism.

Acknowbacter stutteri (Lchmaoo and Neumann) Bergey et al., (Bacillus dentificans 11, Burri and Stutter, Cent. I. Bakt., II Abt., 1, 1805, 302; Bacterum stutteri Lehmann and Neumann, Bakt. Disg., 1 Aufl., 2, 1806, 237; Bacillus nitrojenes Migula, Syst. d. Bakt., 2, 1900, 783; Bacillus stutteri Chester, Man Determ. Bact., 1901, 225; Bergey et al., Manusl, 3rd ed., 1930, 207.) From hores manure. See Manual, 4th ed., 1934, 221 for a description of this organism.

Achromobacter tiogense (Wright) Ber-(Bacillus tiogensis Wright, gey et al Memoirs Nat. Acad. Sci., 7, 1894, 441; Bacterium tiogensis Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 82; Bergey et al., Manual, 1st ed., 1923, 150) From water. See Manual, 4th ed., 1934, 244 for a description of this organism ubiquitum (Jordan) **Achromobacter** Bergey et al. (Bacıllus ubiquitus Jordan, Rept Mass. State Bd. of Health, 1890, 830, Bacterium ubiquitus Chester, Ann. Rept. Del Col. Agr. Exp Sta., 9, 1897, 144; Bergey et al , Manual, 1st ed., 1923,

153.) From sewage, water and dust See Manual, 5th ed., 1939, 517 for a description of this organism.

Achromobacter venenosum (Vaughan)
Bergey et al (Bacillus cenenosus
Vaughan, Amer. Jour. Med Ser, 104,
1892, 191, Bergey et al , Manual, 1st ed.,
1923, 141.) From water Gibbons
(Contrib to Canadian Biol. and Fish,
8, No. 22, 1934, 279) reports this species
from the slime on cod (Gadus callarias)
and the feces of dogfish, (Squalus acui-

thias). See Manual, 4th ed., 1934, 222 for a description of this organism.

Achromobacter visco-symboticum (Buchanan and Hammer) Bergey et al. (Bacillus visco-symbotocum Buchanan and Hammer, Iona Agr. Evp. Sta. Res. Bull 22, 1915, 261; Excherchia symbiotica Bergey et al., Manual, 1st ed., 1923, 202; Bergey et al., 3rd ed., 1930, 203) From ropy milk. See Manual, 4th ed., 1934, 223 for a description of this organism

# Genus III Flavobacterium Bergey et al.\*

(Bergey et al., Manual, 1st ed., 1923, 97, Flavobacter Stewart, Jour. Mar. Biol. Assoc. Un Kingdom, 13, 1932, 31) From Latin flavus, yellow and bacterium, a small rad

rod

Rods of medium size forming a yellow to erange pigment on culture media. Mottle
with peritrichous flagella or non-mottle Generally Gram-negative. Characterized
by feeble powers of attacking carbohydrates, occasionally forming acid from hexoses

but no gas Occur in water and soil

The type species is Flavobacterium aquatile (Frankland and Frankland) Bergey
et al

### Key to the species of genus Flavobacterium.

- Non-motile, and slow or no liquefaction of gelatin
  - A Lltmus milk unchanged
    - 1 Nitrites not produced from intrates
    - 1 Flarobacterium aquatile.
- II Motile with peritrichous flagella.
  - A Gelatin liquefied
    - 1 Litmus milk unchanged.
      - a Nitrites produced from mtrates
        - 2 Flarobacterium diffusum
        - 3 Flanbacterium okeanokoites.
          - 3 Flavobacterium okeanokoite
            4 Flavobacterium rigense.
      - an Nitrites not produced from nitrates
        - b. From fresh water.
- 5 Flatobacterium derorans.
- bb From sea water
- 6. Flarobactersum marinotypicum.
- 7 Flatebacterium marinoi irosum. 8. Flatebacterium halohydrum.
- 9 Flatobacterium neptunium.
- 9 Flatobacterium neptunium

Partully rearranged before his death by Prof D. H. Bergey, Philadelphia,
 Pennsylvama, Sept. 1937; further revision by Prof. Robert S. Breed, New York
 State Experiment Station, Geneva. New York, June, 1915.

- 2. Litmus milk alkaline.
- a. Nitrites produced from nitrates.
  - 10. Flavobacterium suaveolens.
  - 11. Flavobacterium rhenanus
    aa. Nitrites not produced from nitrates.
    - 12. Flavobacterium marinum.
      13. Flavobacterium harrisonium.
- B. Gelatin not liquefied.
  - 1. Litmus milk unchanged.
    - a. Nitrites not produced from nitrates.
    - Flavobacterium invisible.
  - 2. Litmus milk acid.
    - a. Nitrites not produced from nitrates.
      - 15 Flavobacterium lactis

## III. Non-motile.

- A. Gelatin liquefied.
  - Litmus milk unehanged.
- 16. Flavobacterium sewanense
- Litmus milk reduced.
  - a Nitrites not produced from nitrates.
    - 17. Flavobacterium arborescens.
- Litmus milk alkaline.
  - Nitrites produced from nitrates.
    - Flavobacterium lutescens.
    - Flavobacterium fucatum.
- Litmus milk peptonized.
   a. Nitrites not produced from nitrates.
  - 20. Flavobacterium esteroaromaticum.
- 5. Litmus milk acid
  - a Nitrites produced from nitrates
    - 21. Flavobacterium balustinum.
      - 22 Planobacterium dormitator.
- 6. Action on litmus milk not recorded. Rust-colored on blood agar.

  23. Flasobacterium ferrugineum
- B. Gelatin not liquefied
  - 1 Litmus milk unchanged.
    - a. Nitrites produced from nitrates.
      - 24 Flavobacterium proteus.
    - aa. Nitrites not produced from nitrates.
      - · 25. Flavobacterium breve.
      - 26. Flavobacterium solare.
- C. Action on gelatin not recorded
  - Litmus milk unchanged
    - a Nitrites produced from nitrates.
      - 27. Flavobacterium flavotenue.
- 1. Flavobacterium aquatile (Frankland and Frankland) Bergey et al. (Bacillus aquatilis G. and P. Frankland,
- Ztschr. f. Hyg., 6, 1889, 381; Bacterium aquatilis Chester, Ann Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 96; Bergey et

al., Manual, 1st ed., 1923, 100.) From Latin gaugulus, aquatic

Description taken from Frankland and Frankland and from studies by Dr E Windle Taylor, Metropolitan Water Board, London, on freshly isolated cultures.

Rods 05 by 25 microns, with rounded ends, occurring singly, in pairs and in chains. Oscillatory movement only; long threads often remaining motionless (Franklands) Gram-negative (Taylor)

Gelatin colonies · Center yellow-brown, with radiate arrangement of hundles of threads. Colorless margin Very slow liquefaction (none in 6 weeks, Taylor). Gelatin stab. Yellow surface growth.

Slow liquefaction. Agar slant . Yellow, smooth, glistening

limited growth Broth Turbid with whitish sediment

No pellicle Litmus milk. Unchanged (Taylor) Potato. Limited, yellow streak to no

growth

Indole not formed (Taylor). Nitrites not produced from mirates

Aerobic, facultative, Optimum temperature 25°C.

Distinctive characters Resembles Flavobacterium arborescens microscopically, easily distinguished from this organism by its much slower and limited growth on ordinary gelatin and agar media, the marked difference in the appearance of colonies and the mability of Flavobacterium aquatile to produce more than a limited growth on potato

Source: Isolated from the water of deep wells in the chalk region of Kent. England where it occurred as a practically pure culture. Found abundantly and reisolated by Taylor, 1941 from the same (noises (personal communication)

Habitat Water

Note The peritrichous, nitrote reducing and ammonia producing organism identified by Bergey (loc. cit ) in 1923, as Flarobacterium aquatile appears to have been something resembling Flavobacterrum diffusum.

2. Flavobacterium diffusum (Frankland and Frankland) Bergey et al. (Bacillus diffusus G. and P. Frankland, Ztschr. f. Hyg., 6, 1889, 396; Bacterium diffusus Chester, Ann. Rept. Del. Col. Agr. Evp. Sta , 9, 1897, 97; Bergey et al., Manual, 1st ed., 1923, 100.) From Latin diffusus, spreading out, diffuse.

Description completed from Harrison (Canadian Jour. Res., 1, 1929, 233) as

indicated.

Rods: 05 by 15 microns, occurring singly and in chains. Motile, possessing peritrichous flagella Gram-negative (Harrison).

Gelatin colonies: Thin, hluish green, spreading, later faint yellow.

Gelatin stah: Thin, glistening, yellowish-green surface growth Slow crateriform liquefaction.

Agar slant Thin, light yellow, glisten-

Broth. Turbid, with greenish-yellow sediment.

Litmus milk Unchanged (Harrison). Potato: Thin, smooth, greenish-yellow, glistening growth.

Indole not formed (Harrison). Nitrites produced from nitrates (Har-

rison). Slight acidity from glucose. No acid from sucrose and lactose (Harrison).

Acrohic, facultative

Optimum temperature 25° to 30°C. Source: Originally found in soil. Found also by Tataroff (Die Dorpater Wasserbakterien, Dorpat, 1891, 58) in fresh water and hy Harrison (loc cit.) from skin of halibut from both the At-

lantic and Pacific shores of Canada. Habitat Soil, fresh and sea waters.

3. Flavobacterium okeanokoites Zo-Bell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif. 5, 1944. 270.) From Greek Occanus, the ocean god, the occan and costes, bed.

Rods: 08 to 0.9 by 1.2 to 16 microns. with rounded ends, many coccoid, oceurring singly and in long chains.

Motile by means of peritrichous flagella. Gram-negative.

All media except the fresh-water broth. litmus milk, and potato were prepared with sea water.

Gelatin colonies: Small, circular, convex, entire, rust or orange colored, digest gelatin.

Gelatin stab: Slow napiform liquefaction, yellow growth.

Agar colonies: 2 mm. circular, entire. smooth, convex.

Agar slant: Moderate, filiform, glistening, butyrous growth with vellow pigment.

Sea-water broth: No pellicle, moderate turbidity, moderate viscid sediment.

Fresh-water broth: Good growth, Litmus milk: No visible change. Casein is digested.

Potato: No visible growth.

Indole not formed.

Nitrites slowly produced from nitrates. Does not produce acid or gas from glucose, lactose, maltose, sucrose, glycerol, mannitol, xylose, or saliein.

Starch not hydrolyzed.

Hydrogen sulfide is formed Ammonia produced from peptone but not from urea.

Fats not hydrolyzed.

Aerobie, facultative

Optimum temperature 20° to 25°C. Source: Marine mud.

Habitat Sea water.

4 Flavobacterium rigense Bergey et al. (Bacillus brunneus rigensis Bazarewski, Cent f. Bakt , II Abt , 15, 1905. 1; Bergey et al , Manual, 1st ed., 1923. 100.) From Riga, the name of the city where the species was isolated

Rods: 0 75 by 1.7 to 2.5 microns, occurring singly. Motile, possessing peritrichous flagella. Gram-negative.

Gelatin colonies. Circular, entire to undulate, grayish-white, homogeneous. Gelatin stab: Smooth, yellowish surface growth. Infundibuliform liquefaction Brownish-yellow sediment.

Agar slant: Narrow, whitish streak, becoming yellowish brown, spreading, Pigment is water and alcohol soluble. Insoluble in ether.

Broth: Turbid with pellicle and brownish sediment. Cells capsulated.

Litmus milk: Unchanged

Potato: Yellow, spreading growth The growth turns brownish.

Hydrogen sulfide not formed.

Indole not formed.

Nitrites produced from nitrates. Aerobic, facultative.

Optimum temperature 30°C. Brownish colors develop best at lower temperatures. Orange-vellow colors develop best at 37°C.

Habitat : Soil.

5. Flavobacterium devorans (Zimmermann) Bergey et al. (Bacillus devorans Zimmermann, Bakt. unserer Trink- u. Nutzwässer, Chemnitz, 1, 1890, 48; Bacterium devorans Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 96; Bergey et al., Manual, 1st ed., 1923, 102.) From Latin devorans, devouring.

Characters added to Zimmermann's description by Bergey (loc. cit.) from his private notes are indicated. Steinhaus (Jour. Bact., 42, 1941, 771) apparently found the same organism.

Rods: 0.7 by 0.9 to 1.2 microns, occurring singly, in pairs and chains. Motile (Zimmermana), possessing peritrichous flagella (Bergey). Gram-negative (Zim-

mermann). Gelatin colonies: Circular, white, gran-

ular to filamentous, becoming yellowish-Gelatin stab: Slow infundabuliform

liquefaction

Agar slant: Thin, gray, spreading Broth . Turbid.

Litmus milk: Unchanged.

Potato: No growth (Zimmermann).

Yellowish-gray streak (Bergey). Indole not formed

Nitrites not produced from nitrates (Bergev).

Aerobic, facultative.

Ontimum temperature 25° to 30°C.

Source From water at Chemnitz (Zimmermann). From water (Bergey). From alimentary tract of the nine-spotted lady beetle (Coccinella novemnotata Habst.) (Steinhaus)

Habitat: Water.

6. Flavobacterium marinotypicum Zo-Bell and Upham. (Bull. Seripps Inst. of Oceanography, Univ. Calif., 5, 1944, 268.) From Latin marinus, of the sea and typicus, typical.

Roda: 05 to 07 by 1.4 to 20 microns, occurring almost entirely as single cells. Motile by means of four or more peritrichous flagella. Gram-negative.

All media except the fresh-water broth, litmus milk, and potato were prepared with sea water.

Gelatin colonies: Very minute, yellow, with slow liquefaction.

Gelatin stab: Crateriform houefaction becoming stratiform. Filiform along line of stab.

Agar colonies. Minute, circular, entire, convex. vellow.

Agar slant: Scanty, filiform, butyrous, shiny growth with yellow pigment

Sea-water broth: Scanty, yellowish pellicle, heavy turbidity, slight viscid sediment.

Fresh-water broth Good growth Litmus milk: Decolorized, neutral, greenish pellicle, slow peptonization.

Potato: Abundant, shiny, greenish-yellow growth. Potato darkened.

Indole not formed

Nitrites not produced from nitrates Produces acid but no gas from glucose

and glycerol. Does not ferment lactose, sucruse, mannitol, xylose, or saliem.

Starch not hydrolyzed.

Hydrogen sulfide is formed. Ammonia produced from peptone hut not from urea.

Fats not hydrolyzed. Aerobic, facultative.

Optimum temperature 20° to 25°C. Source: Sea water and marine mud. Habitat: Sea nater

7. Flavobacterium marlnovirosum Zo-Bell and Upham. (Bull, Scripps, Inst. of Oceanography, Univ. Calif., 5, 1944, 271 ) From Latin marinus, of the sea, and virosus, covered with slimy liquid or 0010

Rody 07 to 08 by 08 to 28 microns. with rounded ends, occurring singly and in long chains Motile by means of peritrichous flagella. Gram-negative.

All media except the fresh-water broth. litmus milk, and potato were prepared

with sea water Gelatin colonies: Small, circular,

raised, rust-colored. Slowly digest gelstin. Gelatin stab: Crateriform liquefaction

becoming stratiform Light orange pig-Agar colonies . 1 to 2 mm, circular, con-

vex, entire, smooth Agar slant : Moderate, filiform, glisten-

ing, mucoid growth with grayish-yellow pigment.

Sea-water broth, Heavy turbidity, no pellicle, abundant viscid sediment. Fresh-nater broth: Good growth.

Litmus milk: No visible change. Casein is digested.

Potato . No visible growth.

Indole not formed. Nitrates not produced from nitrates.

Does not ferment glycerol, glucose, lactore, maltose, sucrose, mannitol, xylose, or saliein.

Starch not hydrolyzed

Hydrogen sulfide is formed.

Ammonia produced from peptone but not from urea.

Tats not hydrolyzed.

Aerobic, facultative.

Optimum temperature 20° to 25°C. Source: Sea water and marine mud. Habitat: Sea water.

8. Flavobacterium halohydrium ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 278.) From Greek hals, salt and hydror, water.

Short rods: 0.6 by 0.8 to 1.0 microns, occurring singly. Motile by means of many peritrichous flagells. Gram-negative.

All media except the fresh-water broth, litmus milk, and potato were prepared with sea water.

Gelatin colonies: Small, eircular, orange.

Gelatin stab: Napiform liquefaction becoming crateriform. Beaded along line of stab.

Agar colonies: 2 mm, pulvinate, circular, entire, smooth.

Agar slant: Moderate, glistening, echinulate, butyrous growth with yellow pigment.

Sca-water broth: Yellow surface ring, heavy turbidity, moderate viscid sediment.

Frosh-water broth: No visible growth.

Litmus milk: No visible change.

Casein not digested.

Very poorly tolerant of increases or deereases in salinity.

Potato. No visible growth.

Indole not formed.

Nitrites not produced from mirates.

Produces acid but no gas from glucoso, artose, maltase, success, and salicio.

factose, maltose, sucrose, and salicio.

Does not ferment glycerol, mannitol, or xylose.

Starch is hydrolyzed

Hydrogen sulfide not formed.

Ammonia produced from peptoce but not from urea.

Fats not hydrolyzed.

Aerobic, facultative

Optimum temperature 20° to 25°C Source. Ses water and marine mud.

Habitat: Sea water.

 Flavobacterium neptunium ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 6, 1944, 278.)
 From Latin Neptunius, god of the sea-Rods: 05 to 0.6 by 1.6 to 4.5 microns,

Rods: 0 5 to 0.6 by 1.6 to 4.5 microns, many bent rods, occurring singly and in

short chaios. Motile by means of long, peritrichous flagella. Gram-negative.

All media except the fresh-water broth, litmus milk, and potato were prepared with sea water.

Gelatin colonies: Small, circular, darker cecters, sink in gelatin, faintly yellow.

Gelatin stab: Slow napilorm liquelaction. Filiform growth along line of stab. Agar colonies: 2 mm, circular, smooth, entire, convex, dark centers with buff bizment.

Agar slaot: Luxuriant, echiqulate, glistening, slightly mucoid growth with bull to yellow pigment. Agar discolored brown.

Sea-water broth: Heavy pellicle, scanty turbidity, scanty sedimeot.

Fresh-water broth: No visible growth. Litmus milk: No visible change. Casein not digested.

Potata: No visible growth.

Indole not formed.

Nitrites not produced from nitrates Produces acid but no gas from glucose, lactose, maltose, and salicin. Does not ferment glycerol, mannitol, xylose, or success.

Starch is hydrolyzed.

Hydrogen sulfide not formed.

Ammonia produced from peptone but not from urea.

Fats not hydrolyzed.

Aerobie, facultative.

Optimum temperature 20° to 25°C.

Source: Marine bottom deposits.

Habitat : Sea water.

 Flavobacterium suaveolens Soppeland. (Jour. Agr. Res., 28, 1924, 275)
 From Latin suaveolens, of a sweet odor.

Hods: 0.6 to 0.8 by 1.0 to 1.2 micros, with rounded ends, occurring singly and in pairs. Mottle, with peritrichous fagella. Gram-negative on plain agar. Gram-positive in young culture on mike powder sam:

Gelatin stab. Rapid stratiform liquefaction. Medium becomes brown.

Agar colonies: Small, circular, smooth, yellow, amorphous, undulate margin.

Agar slant: Moderate, flat, glistening, opaque, butyrous, vellow, with aromatic odor

Broth. Turbid with scanty sediment Aromatic odor, becoming cheesy

Litmus milk: Peptonized Alkaline. Potato: Abundant, yellow, glistening, becoming brown.

Indole formed.

Nitrites are produced from nitrates.

Hydrogen sulfide formed

Slight acid but no gas from glucose, sucrose and glycerol. No acid from laetose

Starch hydrolyzed.

Blood scrum is liquefied Aerobie, facultativo.

Optimum temperature 25°C. Source · Dairy wastes.

Habitat . Unknown

11 Flavobacterlum rhenanus (Migula) Bergey et al. (Rhino water bacillus of Burri, Frankland and Frankland, Microorganisms in Water, 1891, 483. Bacillus rhenanus Migula, Syst. d Bakt., 2, 1900, 713, Bacillus theni Chester, Manual Determ Baet , 1901, 251; Bergey et al , Manual, 1st ed , 1923, 103 ) Named for the Rhine River.

Characters added to Burn's description by Bergey (loc cit ) from his private notes are indicated Steinhaus (Jour Bact , 42, 1911, 771) apparently found the same organism and has added other characters

Rods 07 by 25 to 3.5 microns, with rounded ends, occurring singly and in chains (Burri). Motile, possessing peritrichous flagella (Bergey) Gram-negative (Bergey)

Gelatin colonies Convex, colorless, trausparent, becoming yellowish Gelatin stab Infundibuliform hque-

faction Agar colonies Small, smooth, convex,

entire. Glycerol agar slant Thun, sharong, honey-colored Growth dry and tough

Broth: Turbid, with orange-colored pellicle and sediment

Litrous milk: Soft congulum, becoming slightly alkaline with vellow ring

Potato Moist, glistening, thin, flat, orange to rust-colored

Indole not formed (Bergey).

Nitrates produced from nitrates (Bergey)

Acid from glucose, maltose, and sucrose but not lactose (Steinhaus).

No bydrolysis of starch (Steinhaus). No H2S produced (Steinhaus).

Aerobic facultative

Optimum temperature 30°C.

Source. From Rhine River water (Burn). From water (Bergey) From eggs in ovary of a walking stick (Diapheromera femorata Say) (Steinhaus).

Habitat, Presumably widely distributed in nature.

12. Flavobacterium marinum Harrison. (Canadian Jour. of Research. 1. 1929, 234) From Latin marinus, pertaining to the sea

Rods. 08 by 1.2 to 1.3 microns, with rounded ends Occur singly and in pairs. Motile with 4 to 5 peritrichous flagella. Encapsulated. Gram-variable. Show blue granules in Gram-negative mda.

Gelatin colonies Circular, tridescent. whitish margin with pale yellow center. Laquefaction.

Gelatin stab Saccate to stratiform liquefaction

Agar colonies Circular, pale yellow, smooth, convey, granular, reticulate edge. Agar slant Amber-yellow, slightly

raised, spreading, smooth, glistening, transparent Ammonium phosphate agar. Scant

growth

Broth Turbid, sediment

Litmus milk: Alkaline. without coagulation. Clear serum

Potato: Abundant, amber-yellow, becoming dirty yellow, spreading, glistening

Indole not formed.

Nitrites not produced from nitrates.

Trace of ammonia formed.

Faint acidity from glucose. No action on lactose or sucrose.

Loeffler's blood serum not liquefied. Faint yellow spreading growth.

No H2S formed.

Aerobic, facultative.

Optimum temperature 20° to 25°C.

Source: Isolated from living halibut obtained at 30 to 50 fathoms, Pacific Occan. Gibbons (Contrib. to Canadian Biol. and Fish., 8, No. 22, 1934, 279) reports this species as occurring in the slime and Icees of eod (Gadus callarias), halibut (Hippoglossus hippoglossus) and skate (Raja crinacea).

Habitat. Skin and feces of fishes.

13 Flavabacterium barrisonii Bergey et al. (Variety No. 6, Harrison, Rev. gén. du Lait, 8, 1908, 129; Bacillus lactis harrisoni: Conn. Esten and Stocking, Ann. Rept. Storrs Agr. Exp. Sta, 1909, 199; Bergey et al., Manual, 1st ed., 1923, 104.) Named for Prof. F. C. Harrison, the Canadian bacteriologist who first isolated this species.

Rods: 0 25 to 0.75 by 0.3 to 3 5 microns, occurring singly and occasionally in short chains. Motile, possessing pentricbous

flagella. Gmm-negative.

Gelatin colonies. Small, gray, glistening, lobular, citron-yellow, shmy.

Gelatin stab. Villous growth in stab. Slow crateriform to napiform liquefac-

Agar slant: Luxuriant, viscous, spreading, becoming dirty, to brownish citronvellow.

yellow.

Broth: Turbid, with viscid ring and gelatinous sediment, sweetish odor, alkaline.

Litmus milk: Colorless to gray and slimy, becoming yellow, alkaline.

Potato. Luxuriant, yellow, spreading, slimy.

Indole not formed.

Glucese, lactose, maltose and sucrose broth turn alkaline with a disagreeable odor. Reaction of glycerol broth remains neutral.

Aerobic, facultative.

Optimum temperature 25°C. Source: Slimy milk.

Habitat: Unknown

14. Flavobacterium Invisibile (Vaughan) Bergey et al. (Bacillus invisibilis Vaughan, American Jour. Med. Sci., 104, 1892, 191; Bacterium invisibilis Chester, Ann. Rept. Del. Col. Agr. Exp. St. 1, 9, 1897, 77; Bergey et al., Manual, 1st ed., 1923, 199.) From Latin invisibilis, not visibile.

Rods: 0 6 to 0.7 by 1.2 to 2 0 microns, occurring singly. Motile, possessing peritrichous flagella. Gram-negative.

Gelatin colonies: Pale yellow, burrlike, with irregular margin.

Gelatin stab: Scanty growth on surface. Good growth in stab. No liquefaction. Agar colonies: White, convex, smooth,

serrate.

Agar slant: Limited, thick, white streak.

Broth : Turbid.

Litmus milk: Unchanged.

Potato: No growth.

Indole not formed.

Natrites not produced from nitrates.

Aerobic, facultative.

Aerobic, facultative.

Optimum temperature 35°C.

Habitat Water.

15. Flavobacterium lactis Bergey et al. (Bocillus oromaticus lactis Grimm, Ceat. Bakt., II Abt., 8, 1902, 584; Bacillus aromaticus Grimm, ibid., 589; not Bacillus aromaticus Pammel, Bull. 21, Iowa Agr. Evp. Sta., 1893, 792; Berge et al., Manual, 1st ed., 1923, 103) From Latin Iac, milk.

Rods 0.7 to 10 by 3.5 to 40 microns, occurring singly, in pairs and in chains. Motile, possessing peritrichous flagells.

Gram-negative. Gramler light yellow, sli

No liquefaction.

Agar slant: Slimy, yellowish, smooth, moist.

Broth: Turbid, with abundant sediment.

Litmus milk: Slightly acid.

Potato . Thick, slimy, brownish, with yellowish margin.

Indole not formed.

Nitrites not produced from nitrates Cultures have pleasant odor.

Aerobie, facultative.

Optimum temperature 25°C Source: Isolated from milk Habitat · Unknown

16. Flavobacterium sewanense (Kalantarian and Petrossian) Bergey et al Bacterium sewanense Kalantarian and Petrossian, Cent f Bakt, II Abt, 85, 1932, 431; Borgey et al , Manual, 4th ed , 1934, 160 ) From M. L. Sovan, a lake in Armenia.

Straight or curved rods: 10 to 2.0 by 40 to 50 microns on Molisch's agar, on ment extract agar and potato agar they are short or even eoccord Ends rounded, occurring singly or in pairs. Non-motile Gram reaction not given. Presumably negative.

Gelatin stah : Slow liquefaction.

Agar colonies Circular, raised, glistening, dirty white. Deep colonies yellow and leas-shaped

Agar slant: Abundant, dirty yellow, glistening, raised.

Turbid with characteristic growth forms. Pellicle formed in old cultures.

Milk: Unchanged

Potato: Yellow, raised, glistening, with darkening of the medium.

No visible gas produced from carbohydrates.

Crystals of calcium carbonate form in old cultures on CaCl, and Molisch's agar.

Acrobic, facultative. Optimum temperature 20°C.

Source, Isolated from pelliele formed on surface of fish infusions in Lake Sevan and tap waters containing 1 per cent CaCl

Habitat: Sea water. Thought to produce deposits of CaCO, in Lake Sevan, S. S. R. Armenia.

17. Flavobacterium arborescens (Frankland and Frankland) Bergey et al (Bacillus orborescens Frankland and Frankland, Ztschr. f. Hvg . 6, 1889, 379; also see Tils, Ztschr. f Hvg., 9, 1890, 312; Zimmermann, Bakt, unserer Trink u. Nutzwässer, 2, 1894, 20; and Wright, Mem. Nat. Acad Sci., 7, 1894, 446, var. a and b: Bacterium arborescens Chester. Ann, Rept. Del Col. Agr. Exp Sta , 9, 1697, 106; Migula, Syst. d Bakt., 2, 1900, 468 uses Bacillus arborescens in the text by mistake as Bacterium is used for other species in the genus and Bacterium arborescens is used in the index, p. 1058: not Bacillus arborescens Chester, Man Determ, Bact , 1901 , 249 , Eruthrobacullus arborescens Holland, Jour. Bact., 5, 1920. 217; Bergey et al , Manual, 1st ed., 1923. 113 ) From Latin arborescens, becoming a tree or tree-like.

Rods: 05 by 25 mierons, occurring singly and in chains. Non-motile (Franklands). Gram-negative (Zimmermann). Gelatin colonies: Radiate branching

filaments. Center yellowish, border translucent. Gelatin stab: Liquefied with vellow

deposit.

Agar slant: Dirty orange growth. Broth · Turbid, with orange sediment No pellicle.

Litmus milk. Slow coagulation, litmus reduced. Reaction unchanged (Wright).

Potato Deep orange, luxuriant growth Natrates not produced from nitrates.

Aerobic, facultative. Optimum temperature 30°C.

May belong to Corynebacterium (Leh-

mann and Neumann, Bakt. Ding., 7 Aufl. 2. 1927, 709).

Source: From river and lake water. Habitat: Water

17a Bacillus arborescens Chester.

(Bacillus arborescens non-liquefaciens Ravenel, Mem. Nat. Acad. Sci., 8, 1896.

39; Bacterium arborescens non-liquefacions Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 103; not Bacterium arborescens non-liquefaciens von Rigler, Hyg. Rund., 12, 1902, 479; Chester, Man. Determ. Bact., 1901, 249.) Regarded by author as a non-liquefying strain of Bacillus arborescens l'rankland and Frankland Not a yellow chromogen. From soil.

18. Flavobacterlum lutescens (Migula) Bergey et al. (Der gelbe Bacillus, Lustug, Dugnostik der Bakterien des Wassers, 1893, 78; Bacterium lutescens Migula, Syst d. Bakt., 2, 1909, 476; Bergey et al. Manual, 1st ed., 1923, 114.) From Latin lutum, yellow; lutescens, becoming yellowish

Rods 05 by 095 micron, occurring singly and in pairs. Non-motile. Gramnegative

Gelatin colonies. Circular, yellow,

Gelatin stab Slow houefaction.

Agar slant Pale yellow, becoming

Broth: Turbid

Litmus milk Alkaline

Potato Luxuriant, golden-yellow growth.

Indole not formed

Nitrites produced from nitrates Aerobic, facultative

Optimum temperature 30° to 35°C Source From water Gibbons (Contrib. to Canadam Biol. and Fish. 8, No. 22, 1934, 279) reports this species as occurring in the shine of the cod (Gadus collarias).

Habitat Fresh and salt water

Flavobacterium fucatum Harrison.
 (Canadian Jour. of Research, 1, 1929,
 From Latin fucatus, painted, colored.

Rods: 08 to 10 by 2.5 to 3.5 microns, slightly bent, with rounded ends. Granular with diphtheroid forms at 37°C. Nonmotile. Gram-negative.

Gelatin colonies: Circular, yellow, entire, paler at edges

Gelatin stab: Crateriform liquefaction Agar colonies: Circular, buff-yellon, smooth, shiny, convex to pulvinate, granular, entire.

Agar slant: Moderate, light buff-yellow, spreading, shiny, smooth.

Ammonium phosphate agar: Good growth in 6 days. Broth: Turbid, becoming clear, pellule

Broth: Turbid, becoming clear, pellicle and yellow sediment.

Litneus milk: Alkaline. Peptonized Clear serum. Yellow sediment.

l'otato: Abundant, pale buff-yellow, smooth, spreading, becoming orange-yellow.

Indole not formed.

Nitrites produced from mirates. Traces of ammonia formed.

No neid from glucose, lactose or suc-

Loeffler's blood serum not liquefied Light buff-yellow growth becoming ochraceus salmon.

No II-S formed.

Aerobic, facultative.

Optimum temperature 20° to 25°C.
Source: Repeatedly isolated from living halibut obtained at 30 to 50 fathors.)
Pacific Ocean. Also isolated by Gibbons (Contrib. to Canadian Biol. and Fish. 8, No. 22, 1934, 279) from cod (Gadus callarus) and dogfish (Squalus acanthus).

Habitat: Skin of fishes.

20. Flavobacterium esteroaromaticum (Omelauski) Bergoy et al. (Bactrium esteroaromaticum Omelianski, Jour. Bact., 8, 1923, 407; Bergey et al., Manual, 3rd ed., 1930, 149.) From M. L., ester and Greek aromaticus, aromatic.

Rods 05 by 1.0 to 30 microns Nonmotile. Gram reaction not recorded.

motile. Gram reaction not recorded Gelatin stab: Crateriform liquefaction with odor of musk melons.

Agar colonies: Circular, yellow-brown, with fimbriate margin and a fruity aroma

fruity aroma.

Broth: Turbid, slight sediment Litmus milk: Pentonized. Cheesy

odor. Potato: Abundant growth Disagree-

able odor. Loeffler's blood serum Liquefied Indole not formed.

Natrites not produced from nitrates

Ammonia formed. Hydrocen sulfide formed

Fat hydrolyzed.

Methylene blue reduced No acid from carbohydrates.

Aerobie, facultative

Optimum temperature 30°C Source . Accidental contaminant in rabbit brain containing rabics virus

Habitat. Presumably widely distributed.

21. Flavobacterium balustinum Harri-(Canadian Jour Research, 1, 1929, son

Rods 06 by 20 to 4.0 microns, forming short chains. Non motile Gram-nega-

Gelatin colonies. Circular, bright yel-

low center, entire

Gelatin stab · Liquefied Agar colonies Punctiform, cadmiumyellow, convex, shiny, transparent

Agar slant. Egg yolk-yellow, semitransparent streak, smooth, shiny, be-

coming brownish-yellow. Ammonium phosphate agar Slight yel-

low growth. Broth Turbid, with yellow sediment Litmus milk: Slightly acid with yellow

sediment. Potato Scant, yellow growth

Indole not formed

Nitrites (trace) produced from nitrates Ammonia not formed No action Faint acidity from glucose

on lactose or sucrose. Loeffler's blood serum not hquefied

Egg yolk-like growth

No II's formed.

Aerobic, facultative.

Optimum temperature 20° to 25°C. Source: Isolated from living halibut obtained at 30 to 50 fathoms. Pacific

Ocean.

Habitat . Skin of fishes.

Flavobacterium dormitator (Wright) Bergey et al. (Bacıllus dormitator Wright, Memoirs Nat. Acad Sci., 7. 1895, 442, Bacterium dormitator Chester. Ann Rept. Del. Agr. Exp Sta., 9, 1897. 109; Bergey et al., Manual, 1st ed., 1923, 115 ) From Latin dormitator, one who sleeps

Description completed from Harrison (Canadian Jour, Res., 1, 1929, 233) whose cultures differed in some particulars from Wright's

Rods with conical cuds, occurring singly, in pairs and in chains Non-motile. Gram-negative (Harrison).

Gelatin colonies. Small, yellow, slightly granular, liquefying

Gelatin stab. Infundibuliform lique. faction, yellow sediment.

Agar slant. Yellow, glistening, translu-

Ammonium phosphate agar. Slight yellon growth

Broth Turbid, with slight pellicle and yellow sediment. Litmus milk Slightly acid; litmus re-

duced. Harrison reports no reduction Potato Slight, transparent, yellow growth

Indole not formed (Harrison).

Nitrate (trace) produced from natrates (Ifarrison).

Acid from glucose, sucrose, glycerol and mannitol. No acid from lactore, raffinose, and inula (Harrison)

Aerobie, facultative Optimum temperature 30°C

Source. Originally isolated from fresh water at Philadelphia Later isolated by Harrison (loc. cit.) from skin of halibut taken in Pacific ocean off Canada bons (Contrib. to Canadian Biol and Fish , 8, No. 22, 1934, 279) reports this Hence it is impossible to identify them definitely as belonging in Planobacterium. Comparative study is needed in some cases before other species listed here can be placed in their proper place in the gonus.

Flavobacterum acidifeum Steinhaus. (four. Bact., 42, 1911, 772.) From the intestine of the grasshopper (Conocephalus fasciatus De G.), the Colorado potato beetle (Lephnotares decembineala Say), several unidentified lady beetle larvae, and the white cabbage butterfly (Pierrs rapae L).

Flavohacterium antenniforme (Ilavenel) Bergey et al (Bacillus antenniformis Rayenel, Memoirs Nat Acad. Sci., 8, 1896, 25; Bacterium antenniformis Chester, Ann Rept. Del. Col. Agr. Exp Stn., 9, 1897, 91, Bergey et al., Manual, 1st ed., 1923, 101) From soil. See Manual, 5th ed., 1939, 531 for a description of this organism

Flavobacterum qurantiacum (Frankland and Frankland) Berger et al (Bacillus aurantiacus G. and P. Frankland, Zeitschr. I. Hyg., 6, 1889, 390, Bacterum aurantiacus Chester, Ann Rept Del. Col. Agr. Exp. Sta., 9, 1897, 109, Bergey et al., Manual, 1st. ed., 1923, 107, Chromobacterum aurantiacum Topey and Wilson, Princ Bact and Immun, 1, 1931, 405). From water. See Manual, 5th. ed., 1939, 533 for a description of this oreasism.

Flavohacterium aurantinium (Ilammer) Bergey et al (Bacillus aurantinus Hammer, Research Bull, No 20, Iowa Exp Sta., 1915, 149, Bergey et al., Manual, 1st ed, 1923, 197.) From milk See Manual, 5th ed, 1939, 541 for a description of this organism

Flavobacterium aurescens (Ravenel) Bergey et al. (Bacillus aurescens Ravenel, Memorrs Nat. Acad. Sci., 8, 1896, 8; not Bacillus aurescens Frankland and Frankland, Philo. Trans. Roy. Soc. London, B, 1878, 271, Bacterium aurescens Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 105; Bergey et al., Manual, 1st. ed., 1923, 102). From soil, Gibbons (Contrib. Canadian Biol. and Fish., 8, No. 21, 1931, 307) found this species in fillets of haddock (Melanogrammus aeglefinus). See Manual, 4th ed., 1931, 142 for a description of this organism.

Flarobacterium brunneum (Copeland)
Bergey et al. (Bacillus brunneus Copeland, Rept. Filtration Commission, Pittshurgh, 1899, 348; Bergey et al., Manual,
lat ed., 1923, 112.) From water. See
Manual, 5th ed., 1939, 511 for a description of this organism. This may be
Bacillus brunneus Schroeter, but not
Bacillus brunneus Eisenberg. The latter
forms spores.

Flarobacterium buccalis (Chester) Bergey et al. (Bacillus g, Vignal, Arch d. phys. norm. et path., Sér. 3, 8, 1886, 365: Bacillus buccalis minutus Sternberg, Manual of Bact., 1893, 643; Bucterium buccalis minutus Chester, Ann Rept. Del. Col. Agr. Expt. Sta., 9, 1897, 108; Bactersum tignali Migula, Syst. d Bakt., 2, 1900, 443; Bacterium bucollis (sie) Chester, Man. Determ. Bact., 1901, 167; not Bacterium buccale Migula, Syst. d Bakt., 2, 1900, 445; Bacillus ugnalis Nepveux, Thèse Fac. Pharm, Paris and Nancy, 1920, 112; Bergey et al , Manual, 1st ed., 1923, 113.) From salma. See Manual, 5th ed., 1939, 541 for a description of this organism

Flaubactersum butyri Bergey et al. (Bacıllus aromaticus butyri Serenin, Cent f Bakt., II Abt., II, 1963, 264; Bergey et al., Manual, 1st ed., 1923, 1963) From sour cream. Produces an agreeable odor. See Manual, 5th ed., 1939, 534 for a description of this organism.

Flatobacterium chlorum Steinhaus. (Jour Bact., 42, 1941, 772) From the intestine of the nine-spotted lady beetle (Coccincila noremnotata Habst.).

Flavobaclerium denitrificans (Lehmana and Neumann) Bergey et. al. (Bazillus denitrificans I, Burri and Stutzer, Cent f Bakt, II Abt, 1, 1895, 300; Bacterium denitrificans I, Chester, Ann Rept. Del. Col Agr Exp Sta, 9, 1897, 77, Bacterium denitrificans Lehmann and Neumann, Bakt. Diag, 2 Aufl., 2, 1809, 273; Pesudomona stutzeri Migula, Syst d Bakt, 2, 1900, 929, Bacillus dentirificans Chester, Man. Determ. Bact, 1901, 224, Bergey et al., Manual, 1st ed, 1923, 109, Chromobacterium dentirificans Topley and Wilson, Princ. Bact and Immun, 1, 1931, 405) From horse manure. See Manual, 5th ed, 1939, 334 for a description of this organism.

Flatobacterium desvitosum (Wright)
Bergey et al. (Bacillus decidosus (see)
Wright, Memoris Nat. Acad. Sei, 7, 1835,
413; not. Bacillus desidosus MeBeth,
Soil Sci. J., 1916, 450; Bacterium desidosus
and Bacterium desidosus Chester,
Ann Rept. Del. Col. Agr. Exp. Sta., 9,
1897, 107 and 133, Flatobacterium decidosus
orum Bergey et al., Manual, 1st ed., 1923,
114) From water Gibbons (Contrib
Canadian Biol. and Fish., 8, No. 24, 1931,
333) found this species in fillets of haddock (Melanogrammus aeclefum). See
Manual, 5th ed., 1939, 5t4 for a description of this organism.

Flabobacterium flaescens (Pohl) Bergey et al. (Bacillus flaescens Pohl, Cent f Bakt, 11, 1902, 144; Bergey et al, Manual, 1st ed, 1923, 107) From water See Manual, 5th ed, 1939, 535 for a description of this organism

Flaiobacterium flarum (Fuhrmann) Bergey et al. (Bacillus flavus Fuhrmann, Cent f Bakt, 11 Abt., 19, 1907, 117, Manual, 1st ed., 1923, 101) From beer See Manual, 4th ed., 1934, 141 for a description of this organism

Flavobacterium gelatinum Sanborn (Jour Bact , 19, 1930, 376 ) From sea water

Flavobacterium halmephilum Elazari-Volcani (Studies on the microflora of the Dead Sca, Thesis, Hebrew Univ., Jerusalem, 1940, VIII and S.) From the Dead Sca A yellow halophilie species

Flatobacterium halophilum Bergey et al (Culture No 30 of Baranik-Pikowsky, Cent. f. Ikakt., 11 Abt., 70, 1927, 373, Bergey et al., Manual, 3rd ed., 1930, 147.) From sea water. See Manual,

5th ed., 1939, 540 for a description of this organism

Flundoacterium lacunatum (Wright) Bergey et al (Bacillus lacunatus Wright, Memoirs Nat. Acad Sen., 7, 1895, 435, Bacterium lacunatus Chester, Ann. Hept Del Col Agr Exp. Sta., 9, 1897, 110; Bergey et al, Manual, 1st ed., 1923, 117) From water See Manual, 5th ed., 1939, 552 for a description of this oreamsm

Flavobacterium matzoons (Chester)
Bergey et al. (Species No. 45 of Conn,
Storrs Agr Exper. Sta., 7th Ann.
Rept for 1804, 1805, 80; Bacultus matazoons (see) Chester, Man. Determ.
Bact, 1901, 236; Bergey et al., Manual,
lat ed., 1903, 107. From matzoon, a
fermented mult from Armenia. See Manual, 5th ed., 1909, 530 for a description
of this organism.

Flavobacierum ovale (Wright) Bergey et al (Bacillus oralis Wright, Memoirs Nat Acad Sci. 7, 1893, 435; Bacterum ovalis Chester, Ann Rept. Del. Col. Agr Exp Sta. 9, 1897, 111; not Bacterum ocale Migula, Syst d. Bakt., 2, 1903, 483, Bergey et al, Manual, ist ed., 1903, 117) I rom water. See Manual, 5th ed., 1939, 551 for a description of this organism

Flatobactersum plicatum (Zimmermann) Bergey et al. (Bacillus plicatus Zimmermann, Bakt unsere Trink- u Nutxasser, Chemnitz, I, 1890, 51; not Bacillus plactus Frankland and Frankland, Phol Times. Roy Soc. London, 178, B, 1887, 273, Bergey et al., Manual, lat ed., 1923, 103) From water Gramerstuve Non-motile See Manual, 5th ed., 1939, 352 for a description of this organism. See p. 631.

Flavobacterium pruneaeum Sinborn. (Jour Buet, 19, 1930, 376) From sea water

Fluobacterum radiatum (Zimmermann) Bergey et al. (Bacillus radiatus Zimmermann, Bukt unserer Trinku Nutraässer, Chemnitz, 1, 1890, 58; Bacillus radiatus aquatihi Frankland and Frankland, Microorg, in Water, London, 1891, 458; Bergey et al., Manual, Ist ed., 1923, 104.) From water. See Manual, 5th ed., 1939, 531 for a description of this organism. Gram-variable. Slight motility of shorter rods.

Flavobacterium schrokikhii (II. Jensea) Bergey et nl. (Salpeter zerstörendea Baeillus, Schirokikh, Cent. f. Bakt., II Abt., 2, 1896, 205; Bacterium schirakikhi II. Jensen, ibid., 4, 1898, 409; Bacillus denitrificans Chester, Man. Determ. Bact., 1901, 274; Bergey et al., Manual, 1st ed., 1923, 100). From horse manure. See Manual, 5th ed., 1939, 527 for a description of this organism.

Flavobacterium stolanatum (Adametz and Wiehmann) Bergey et al. (Bacillus stolonatus Adametz and Wiehmann, Mitt. Oest. Versuchsstat. f. Brauerei u. Mālz., Wicn, Heft 1, 1888, 881; Bacterium stolonatus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1697, 76; Bergey et al., Manual, 1st ed., 1923, 106.) See Manual, 5th ed., 1939, 535 for a description of this organism. From water.

tremelloides Flavabacterium (Tils) Bergey et al. (Bacillus tremelloides Tils, Ztschr. f. Hyg., 9, 1890, 292; Bacterium tremelloides Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 105, Bergey et al., Maaual, 1st ed., 1923, 105.) From river water at Freiburg. Forms a yellow, slimy milk. See Manusl, 5th ed., 1939, 532 for a description of this organism

Flavabacterium (Halobacterium) maris. mortui Elazari-Volcani. (Studies on the Microflora of the Dead Sea, Thesis, Hebrew Univ., Jerusalem, 1940, V and 48.) From the Dead Sea. This species Flavobacterium (Halobacterium) nnd halobium and Flavobacterium (Halobacterium) trapanicum are placed in a new subgenus of Flavobacterium named Halobacterium. All produce red pigment. The flagellation of these species was not determined. They may be polar flagellate, see Pseudomonas salinaria and P. cutirubra.

Flatobacterium (Halobacterium) halobium (Petter) Elazari-Volcani. (Mierobe du rouge de morue, Le Dantec, Compt. rend. Soc. Biol., Paris, 58, 1902, 136; Bacillus halobius ruber Klebahn, Mitteil, n. d. Inst. f. allg. Bot. Hamburg, 4, 1919, 47; Racterium halobium Petter, Over rood en andere bacteriea van gesauten visch, Diss, Utrecht, 1932; Elazari-Volcani, Studies on the Microflora of the Dead Sea, Thesis, Hebrew Univ., Jerusalem, 1910, V and 59 ) From reddened salted codfish.

Flavobaclersum (Halobacterium) trapanicum (Petter) Elazari-Volcani. (Bacterium trapanicum Petter, Over rood ea andere bacterien van gezouten visch, Diss., Utrecht, 1932; Elazari-Volcam, Studies on the Microflora of the Dead Sca, Thesis, Hebrew Uaiv. Jerusalem, 1940, V and 59.) From the Dead Sea.

#### FAMILY X. ENTEROBACTERIACEAE RAHN.

(Cent. f. Bakt., II Abt , 96, 1937, 280.)

Gram-negative straight rods. Motile with peritrichous flagella, or non-motile. Grow well on artificial media. All species attack glucose forming acid, or acid and visible gas (H; present). Characteristically nitrites are produced from nitrates (exceptions in Erwinio only). Antigenic composition is best described as a mosaic which results in serological interrelationships among the several genera, even extending to other families. Many animal parasites, and some plant parasites causing blights and soft trots. Frequently occur as saprophytes causing decomposition of plant materials containing carbohydrates.

Norn: Early attempts to develop a satisfactory basis for the recognition of species among the coliform-dysentery-typhoid group of bacteria are reviewed by Winslow, Kigler and Rothberg (Jour. Bact., 4, 1919, 429). These were largely based on differences in motility, production of indole, ability to liquely gelatin, and, more particularly, differences in the ability to ference asthophyrates, especially such compounds as glucose, lactose, sucrose, dulcitol and saltein. The more recent attempts to express differences in species of coliform bacteris by means of the IMViC reaction are reviewed by Part (Amer. Jour Public Health, 28, 1938, 39) Bact. Rev., 5, 1939, 1), this cryptic symbol indicating the indole test, methyl red acid determination, acetylmethylearbinol production (Yoges-Prokauer reaction) and the studiation of salts of citric acid. Stuart, Griffin and Baker (Jour. Bact., 58, 1938, 301) and Griffin and Stuart (Jour. Bact., 40, 1946, 63) have applied these tests plus cellobics of rementation to a study of a long series of cultures.

Capsulated types of coliform bacteria are still placed in this edition of the Manual in a separate genus, Klebsiella, although there is some question about the

separation of these from the species in Escherichia and Aerobacier.

Meanwhile, the Kaufmann and White Antigenic Schema has been successfully applied to the recognition of serological groups and types among sumencilas and related organisms. The groupings recognized are outlined in the Salmonellas and related organisms. The groupings recognized are outlined in the Salmonella Subcommittee Reports submitted to the End and 3rd Congresses of Microbiology, 1910, 832). The successful use of antigenic structure in this field has stimulated a study of the use of H and O antigens as a means of classifying the coliform group (Surat, Baker, Zimmerman, Brown and Stone, Jour Bact., 49, 1949, 101) but this method of classifying the species of coliform bacteris has not proved particularly helpful as yet.

During this same period there has been an increasing appreciation of the clossness of the relationship between certain common chromogene bettern (Everatio) and the coliform bacteria (Birect and Birect, Cent. I. Bakt., II Abt., 71, 1927, 435). Moreover, the close relationship between bacteria producing soft rots of I ving vegetable and other plant tissue (non included in Ermino) and the coliform bacteria has become more evident in recent studies (Waldee, lowa State Coll. Jour. Sci., 10, 1915, 435). Many intermediate types are found in rotting vegetable materials, these rotting types having the ability to attack protopectin (Burkey, Iowa State Coll. Jour Sci., 3, 1928, 67) but not to cause soft rots of Ilving plant tissue.

Borman, Stuart and Wheeler (Jour. Bact., 48, 1914, 351) have proposed a rearrangement of the species in the Iamily Enterobacteriaecae which combines many forms that have previously been regarded as sepante species, or even as belonging in separate genera. Only the future can determine which of all of these views best expresses the relationships of the bacteria belonging in the Family Enterobacteriaecae.—The Editors.

### Key to the tribes of family Enterobacterlaceae.

 Ferment lactose with the formation of acid and visible gas within 24 hours at 37°C or within 48 hours at 23° to 30°C. Some transitional forms produce acid and gas from lactose slowly.

Tribe I. Eschericheae, p. 441.

II. Plant parasites. Ferment lactose with formation of acid, or acid and visible gas Usually attack middle lamellar substance in plant tissues, causing soft rots. Tribe 11. Eruinate, p. 433.

111. Ordinarily chromogenic producing a pink, red or orange-red pigment. Occasionally non-pigmented. Ferment glucose and lactose with formation of acid, or acid and visible gas.

Tribe III. Serrateae, p. 479.

- Lactose not fermented within 30 days either at 37°C or at 25° to 30°C. Urea decomposed within 48 hours.
  - V. Lactose rarely fermented within 30 days either at 37°C or at 25° to 30°C. Urea not decomposed within 48 hours.

Tribe V. Salmonelleae, p. 492.

# TRIBE I ESCHERICHEAE BERGEY, BREED AND MURRAY.

(Preprint, Manual, 5th ed., October, 1938, vi.)

Ferment glucose and lactose with the formation of acid and visible gas within 24 hours at 37°C, or within 48 hours at 25° to 30°C. Some forms produce acid and gas from lactose slowly (occasionally not at all). Do not liquefy gelatin except slowly in Aerobacter cloacae

### Key to the genera of tribe Eschericheae."

- Acetylmethylcarbinol not produced. Methyl red test positive. Salts of citric acid may or may not be used as a sole source of carbon.
- Genus I. Escherichia, p. 441.
  II. Acetylmethylcarbinol produced. Methyl red test negative. Salts of citric acid used as solo source of carbon.

Genus II. Aerobacter, p. 453.

III. Acetylmethylcarbinol may or may not be produced. Methyl red test variable. Salts of either acid may or may not be used as sole source of carbon. Gas not as abundant as in previous genern. Capsulated forms from respiratory, intestinal and genito-urinary regions.

Genus III. Klebsiella, p. 457.

## Genus I. Escherichia Castellans and Chalmerst.

(Castellani and Chalmers, Manual Trop Med., 3rd ed., 1919, 911; Colibacterium Orla-Jensen, Jour Bact, 6, 1921, 272; Colobactrum (in part) Borman, Stuart and

† Completely revised by Prof. M. W. Yale, New York State Experiment Station,

Geneva, New York, Nov , 1938, further revision, July, 1943.

<sup>\*</sup> Levine (Jour. Bact., 1, 1916, 153) was the first to show the inverse correlation between the methyl red and Voges-Proskauer tests and used these characters for the primary separation of the Escherichia coli section and the Aerobacter aerogenes section (Amer. Jour. Public Health, 7, 1917, 784).

Wheeler, Jour. Bact, 48, 1914, 357) Named for Theodor Escherich, who first isolated the type species

Short rods fermenting glucose and lactose with acid and gris production. Acetylmethylcarbinol is not produced Methyl red test positive. Carbon doxide and hydrogen produced in approximately equal volumes from glucose. Generally not able to utilize uric acid as a sole source of nitrogen. Found in feces and is occasionally pathogenic to man (cohtis, cystius, etc.) It is, however, also widely distributed in nature.

The type species is Escherichia coli (Migula) Castellani and Chalmers.

#### Key to the species of genus Escherichia.

- I Citric acid and salts of citric acid not utilized as sole source of carbon.
  A. Hydrogen sulfide not produced
  - 1. Escherichia coli.
- II Citric acid and salts of citric acid utilized as sole source of carbon.
  - A Hydrogen sulfide produced.
  - B. Hydrogen sulfide not produced

Escherichia coli (Migula) Castellani

- and Chalmers. (Bacterium coli commune Escherich, Die Darmbakterien des Neugeborenen und Sauglings, 1885, Bacillus escherichii Trevisan, I generi e le specie delle Batteriacec, 1889, 15, Bacillus coli communis Sternberg, Manual of Bacteriology, 1893, 439; Bacillus coli Migula, in Engler and Prantl. Naturlichen Pflanzenfam . 1. 1a. 1895. 27. Bacterium coli Lehmann and Neumann, Bakt Diag , I Aufl , 2, 1806, 221, Bacillus coli ierus Durham, Jour Exp Med , 6, 1900, 371; Bacillus cols communis verus Durham, 1bid, 353; Aerobacter coli Benjerinck, Cent. f Bakt., II Abt., 6, 1900, 193, Castellan and Chalmers, Man. Trop Med., 3rd ed , 1919, 941, Bacillus coli-communis Winslow, Kligler and Rothberg, Jour. Buct , 4, 1919, 483,
- Nort Weldin (lowa State Jour Set, 1, 1927, 121) considers the following identical with the above. Bacillus cancula (Tügge, Die Mikroorganismen, 1886, 205 or more probably Brieger, Berlin

Bacterium coli-communis Holland, Jour.

Bact . 5. 1920, 217, Colobactrum cols

Borman, Stuart and Wheeler, Jour Bact.,

48. 1911, 358 ) From Latin colon, the

large intestine

2. Escherichia freundii.

3 Escherichia intermedium.

klin. Wochnschr., 1884, No 14; Bacillus C, Booker, Trans Ninth Internat. Med. Congress, 5, 1887, 508; Bacıllus schafferi von Freudenreich, Landw. Jahrb. d. Schweiz, 4, 1890, 17; Bacterium eavicida Chester, Ann Rept. Del. Col. Agr. Exp. Sta. 9, 1807, 130; Bacterium schafferi Chester, ibid., 74, Bacillus musiclae septicus Matzuschita, Bakt, Diag . 1902; Bacillus communis Jackson, Jour. Inf. Dis , 8, 1911, 211, not Bacillus communis Migula, Syst. d. Bakt , 2, 1900, 725; Escherichia catterda Castellani and Chalmers, Manual of Trop. Med , 3rd ed., 1919, 912, Escherichia schaeffert Bergey et al., Manual, 1st ed., 1923, 196,

Oesterle (Cent. f Bakt., I Abt., Orig., 134, 1935, 115) has described a yellow strain Bacterium coti flavum, Part (Proc. Soc Exp Biol. and Med., 35, 1937, 563) a golden-brown strain Bacterium aurescens (not Bacterium aurescens Migula, Syst. d Bakt., 2, 1909, 166), and Tritsler (Jour. Bact., 33, 1937, 459) reddish-orange strains which are regarded as pigmented variants of Echerichia Coli.

Rods: Usually 0.5 by 1.0 to 3 0 microns, varying from almost exceed forms to long rods, occurring singly, in pairs and short chains. Motile or non-mottle, Motile

strains have peritriehous flagella. Not usually capsulated. Non-spore-forming. Gram-negative.

Gelatin colonies: Opaque, moist, grayish-white, entire.

Gelatin stah: Grnyish-white, apreading, undulate. No liquefaction.

Agar colonies: Usually white, sometimes yellowish-white, rarely yellow, yellow-hrown, golden-hrown, reddishorange or red; entire to undulate, moist, homogeneous. Atypical forms occur frequently.

Agar slant: Usually white, sometimes yellowish-white, rarely yellow, yellowbrown, golden-brown, reddish-orange or red growth; moist, glistening, spreading.

Broth: Turbid, with heavy grayish sediment. No pellicle.

Litmus milk: Rapid acid formation with development of gas, usually coagulation, curd may or may not be broken up, no peptonization of the curd. Litmus may or may not he reduced.

Potato: Ahundant, grayish to yellowish-hrown, apreading.

Indole usually formed.

Nitrites produced from nitrates.

Blood agar plates: Different atrains vary widely in their action, some being hemolytic (Buchgraher and Hilké, Cent. f. Bakt., I Aht., Orig., 135, 1935, 449).

Hent resistance: Üsually destroyed in 30 minutes at 60°C, hut certain beatresistant strains may withstand this exposure (Ayers and Johnson, Jour. Agr. Res., 5, 1914, 401; Stark and Patterson, Jour. Dairy Sci., 19, 1936, 495).

Antigenic structure: An antigenically

heterogeneous species.

Methyl red test positive (Clark and Lubs, Jour. Inf. Dis., 17, 1915, 160); Voges-Proskauer test negative (Durham, Jour. Exp. Med., δ, 1901, 373); inverse correlation between methyl red and Voges-Proskauer tests (Levine, Jour. Bact., 1, 1916, 153).

Citric acid and salts of citric acid not utilized as sole source of carbon (Koser, Jour. Bact., 8, 1923, 493).

Uric acid not utilized as sole source of

nitrogen (Koser, Jour. Inf. Dis., 25, 1918, 377); uracil utilized as sole source of nitrogen (Mitchell and Levine, Jour. Bact., 55, 1938, 19).

Gas ratio: Approximately equal volumes of carbon dioxide and hydrogen, ratio 1:1, produced from glucose (Harden and Walpole, Proc. Roy. Soc., Ser. B, 77, 1905, 399; Rogers, Clark and Davis, Jour Inf. Dis., 74, 1914, 4119.

Catalasc produced.

No H<sub>2</sub>S produced in peptone iron agar (Levine, Epstein and Vaugha, Amer, Jour. Puhlic Health, 24, 1934, 505, Titts ler and Sandholzer, Amer, Jour. Public Health, 27, 1937, 1240). More sensitive indicators give positive tests for H<sub>2</sub>S (Hunter and Weiss, Jour. Bact., 55, 1938, 20).

Trimethyleneglycol not produced from glyeerol by amerohic fermentation (Braak, Onderzoekingen over Vergisting van Glycerine, Thesis, Delft, 1923, 166; Werkman and Gillen, Jour. Bact., 23, 1932, 167).

Acid and gas from glucose, fructose, galactose, lactose, maltose, arabinose, xylose, rhamnose and mannitol. Sucrose, raffinose, salicin, esculin, dulcitol and glycerol may or may not he fermented. Variable fermentation of aucrose and salicin (Sherman and Wing, Jour. Bact, 55, 1937, 315; Tregoning and Poe, Jour. Bact., 54, 1937, 473). Inulin, pectin and adonitol rarely fermented. starch, glycogen and inositol not fermented. Cellobiose (Jones and Wise, Jour. Bact., 11, 1926, 359) and α-methylglucoside (Koser and Saunders, Jour. Bact., 24, 1932, 267) not fermented. Certain strains produce variants which ferment lactose slowly or not at all (Rennebaum, Jour. Bact., 30, 1935, 625). Some strains of slow-lactose-fermenters appear to he intermediate between the coliform and paratyphoid groups (Sandiford, Jour. Path. and Bact., 41, 1935, 77). See Twort (Proc. Royal Soc. London, 79, 1907, 329) for utilization of unusual glucosides; Dozois et al. (Jour. Bact., 30, 1935, 189 and 52, 1936, 499)

for utilization of certain sugar alcohols and their anhydrides; Pce and Klemme (Jour. Biol. Chem., 109, 1935, 43) for utilization of rare sugars See Winslow, Kligler and Rothberg (Jour. Bact., 4, 1919, 420) for review of literature relative to classification.

Fecal odor produced.

Aerobic, facultative.

Growth requirements Good growth on ordinary laboratory media Optimum growth temperature 30° to 37°C. Growth takes place at 10°C and at 45°C Gas produced from glucose at 45° to 46°C Eijkmann test positive (Eijkmann, Cent. f Bakt., 1 Abt., Org., 57, 1904, 74. Perry and Hajna, Jour. Bact., 22, 1933, 419).

Source: From feces of infants.

Habitat: Normal inhabitant of the intestine of man and all vertebrates Widely distributed in nature. Frequently causes infections of the genitourinary tract. Invades the circulation in agonal stages of diseases

la Escherichia coli var. scidilactica (Toplov and Wilson) Yalo.

(Milcheaurcbacterium, Hueppe, Mit. d. kais. Gesund , 2, 1884, 340, Bacillus geidt lactici Zopf, Die Spaltpilze, 1885, 87; not Bacterium acidi lactici Zopf, Die Spaltpilze, 1884, 60; Bacillus acidi lactics I and II Grotenfelt, Fortschr. d Med., 7, 1889, 121; possibly also Bactersum acidi lactici I and II Grotenfelt, 1bid . 123 . Bacterium acidi lactici Migula, in Engler and Prantl, Naturlichen Pflanzenfamilien, 1, 1a, 1895, 25; not Bacterrum acidi lactici Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 357: not Bacterium B. Peters, Bot. Zeitung, 47, 1889, 422); possibly Bacterium grotenfeldti: Migula, Syst. d. Bakt., 2, 1900, 403, a synonym of Bacterium acids lactici I Grotenfelt; Bacillus acidilactici Jackson, Jour. Inf Dis , 8, 1911, 241: possibly Bacillus lacticus Mace, Traité pratique de bact., 1913, 452; not Bacillus lacticus Kruse, in Flügge, Die Mikroorganismen, £, 1896, 356; Bacterium dwodenale Ford, Studies from Victoria Hospital, Montreal, I, 1903, 17 (according to Perkins, Jour. Inf. Dis., 37, 1925, 247). Encapsulatus acidi lactici Castellani and Chalmers, Manual of Trop Med., 1919, 934; Bacullus lactici-acidi Holland, Jour. Bact, 5, 1920, 218; Bacterium acidilactici Holland, sbid.; (Encapsulatu) Bacullus dwodenale Perkins, Jour. Inf. Dis., 37, 1925, 247; Escherichia acidilactici Bergey et al., Manual, 1st ed., 1923, 190; Bacterium coli var. acidi lactici Topley and Wilson, Princip. Bact. and Immun., 1, 1931, 446, Yale, in Manual, 5th ed., 1930, 339

Identification: Includes strains of Becherickia coli which do not attack either sucrose or salicin. It is generally thought that Hueppe's cultures were contaminated with a spore-former,

Source: From milk.

Ib Escherichia coli var. neapolitana (Topley and Wilson) Yale (Neapeler Bacterien. Emmerich, Deut. med. Webnschr . 10, 1881, 209 . Bacillus neapolitanus Flügge, Dio Mikroorganismen, 1886. 270, Bacterium neapolitanus Chester, Ann Rept. Del Col. Agr. Exp. Sta., 9, 1897, 138, Escherichia neapolitana Castollani and Chalmers, Man. Trop. Med., 3rd ed , 1919, 942; Bacterium coli var. nea. politanum Topley and Wilson, Princip. Bact. and Immun , 1, 1931, 416, Yale, in Manual, 5tb ed , 1939, 393 )

Identification: Includes strains of Escherichia coli which ferment sucroso and salicin.

Source: From cholera patients or cadavers, originally thought to be the cause of cholera.

1c. Etcherichia coli var. communior (Topley and Wilson) Yale. (Bacultus coli communior Durham, Jour. Exp. Med., 6, 1930, 353; Bucillus communior Ford, Studies from Victoria Hop., Montreal, 1, 1933, 17; Bacterium communior Jackson, Jour. Ind. Dis., 8, 1911, 211; Bacultus coli communior Holland, Jour. Bact., 6, 1950, 217; Bacterium coli communior 1950, 217; Bacterium coli communior Holland, idem; Escherichio cammunior Bergey et al., Manual, 1st ed., 1923, 200; Bacterium celi var. communior Topley and Wilson, Princip, Bact, and Immun. 1, 1931, 416; Yale, in Manual, 5th ed., 1939, 293.)

Yale (Cornell Vet., 23, 1933, 306) regards Bacterium astheniae Dawson (15th Ann. Rpt., Bur. Anim. Ind., US.D.A., 1898, 329; Bacillus osthenioe Winslow, Kligler and Rothberg, Jour. Bact., 4. 1919, 487; Escherichia ostheniae Bergey et al., Manual, 1st ed., 1923, 205) as a synonym of Escherichia communior.

Identification: Includes strains of Escherichio coli which ferment sucrose but not saliein. Levine (Iowa Eng. Exp. Sta. Bul. 62, 1921, 38) recognizes a strain which ferments saliein

Escherichia freundii (Brank) Yale. (Bacterium freundi: Brank, Onderzoekingen over vergisting van glycerine. Thesis, Delit, 1928, 140; Citrobocter freundii Werkman and Gillen, Jour. Bact., 23, 1932, 176; Yale, in Manual, 5th ed., 1939, 394, Coloboctrum freundii Borman, Stuart and Wheeler, Jour. Bact , 48, 1944, 358.) Named for A. Fround, who first observed that trimethylenegiyeol was a product of fermentation (1881).

Minkewitsch (Ztschr. f. Hyg., 111, 1930, 180) proposed the name Bocterium coli citrovorum for the intermediates but this name is not acceptable since it is a trinomial.

Werkman and Gillen (Jour. Baet , 23, 1932, 177) emended the description of Bacterium freundii, and created the genus Citrobacter The following species renamed by Werkman and Gillen are regarded as identical with Escherichia freundii Citrobacter album, Citrobacter decolorans, Citrobacter diversum and Citrobacter anindolicum

Tittsler and Sandholzer (Jour. Bact., 29, 1935, 349) and Carpenter and Fulton (Amer Jour. Pub. Health, 27, 1937, 822) suggest that the intermediates which give a positive methyl red and a negative Voges-Proskauer test be allocated to the genus Escherichia. Other strains are apparently more nearly related to the genus Acrobocter than to the genus Escherichia since they produce acetylmethylcarbinol. Barritt (Jour. Path. and Bact., 42, 1936, 441; 44, 1937, 679) has shown that some of the intermediates form traces of acetylmethylcarbinol which can be detected by the a-naphthol test, but not by the standard Voges-Proskauer test as described in the Manual of Methods for the Pure Culture Study of Bacteria (Soc. Amer. Bact., 1937, 17).

Rods: Short rods with rounded ends, occurring singly, in pairs and short chains. Motile or non-motile. Gramnegative.

Gelatin stab: Liquefaction by 4 out of 15 cultures (Werkman and Gillen, Jour. Baet., 23, 1932, 177). No liquefaction by any strains (Tittsler and Sandholzer, Jour. Bact., 29, 1935, 353; Carpenter and Tulton, Amer. Jour. Pub. Health, 27, 1937, 822).

Agar slant: Smooth, gray, shining, filiform and butyrous growth.

Litmus milk: Acid in 2 days; coagulation may or may not take place; no peptonization.

Potato: Abundant, yellowish-white growth.

Indole may or may not be formed (Werkman and Gillen, loc. cit.; Tittsler and Sandholzer, loc. cit.).

Nitrites produced from nitrates.

Methyl red test positive. Voges-Proskauer test negative (Koser, Jour Bact , 9, 1924, 59). Some strains give a positive methyl red and a positive Voges-Proskauer test (Parr. Jour. Bact., 36, 1938, 1).

Gitrie acid utilized as sole source of carbon; uric acid not utilized as the sole source of nitrogen (Koser, loc. cit.; Werkman and Gillen, loc. cit., 167).

Catalase produced.

Hydrogen sulfide produced in proteose peptone, ferrie citrate agar (Levine, Epstein and Vaughn, Amer Jour. Pub. Health, 24, 1934, 505; Tittsler and Sandholzer, Amer. Jour. Pub. Health, 27, 1937, 1240).

Trimethyleneglycol produced from glycerol by anaerobic fermentation (Brnak, loc. cit, 146, Werkman and Gillen, loc. cit, 167).

Acid and gas from glucose, fuetose, galactose, arahinose, valose, raflinose, lactose, malucose, mannose, rbamnose, trehalose, glycerol, manntol and sorbitol Sucrose, saliein, dulcitol, adonttol and inositol may or may not be fermented Cellobuses usually fermented while a methyl-glucoside may or may not be fermented Cittaler and Sandholzer. De

cit.; Carpenter and Fulton, loc cit). No acid or gas from amygdalin, devtrin, erythritol, glycogen, inulin or melezitose Aerobic, facultative.

Groath requirements Good groath on ordinary laboratory media. Optimum groath temperature 30° to 37°C Gas not produced in Elikanan test when carried out at 45° to 46°C (Levine, Epstein and Vaughn, loc. ct.) No grs at 44°C (Wilson, Med Res, Council, London, Special Rent, Ser. 209, 1393, 165)

Habitat. Normally found in soil and water and to a varying degree in the intestinal canal of man and animals. Widely distributed in nature

3 Escherichia intermedium (Werkman and Gillen) Vaughn and Levine (Citrobacter intermedium Werkman and Gillen, Jour Bact., 23, 1932, 178; Vaughn and Levine, Jour. Bact., 44, 1942, 498)

Citrobacter glycologenes Werkman and Gillen (loc. cit.) is also regarded as a synonym of Escherichia intermedium Yaughn and Levine (loc. cit.) give a new description of Escherichia intermedium based on a study of 27 cultures

Rods: Short rods with rounded ends Occurring singly, in pairs and short chains in young nutrient ager or broth cultures Actively motile with periturchous flagella or non-motile. Gram-negative. Gelatin stah: No liquefaction after 60 days at 20°C.

Agar slant: Smooth to wrinkled surface, grayish-white, abundant, raised and

butyrous grouth.
Nutrient broth: Turbid with slight

ring at surface.

Litmus milk Acid, sometimes congula-

tion and reduction, no proteolysis
Potato Growth abundant, white to

ivory color

Leving's cosine-methylene blue agar:

Lovino's cosine-methylene blue agar: Well-solated colones vary from 1 to 4 mm in size. No confluence of neighboring colonies. Colonies are slightly to moderately raised with surfaces varying from flat to convex and usually amooth and ghistening but sometimes dull, rough and granular.

By transmitted light two types of colonies have been observed. (1) Colonies having almost the same appearance throughout but with a distinctly lighter center, the color being similar to the medium. (2) Colonies having a dark brownish central area which diffuses out to a lighter margin.

By reflected light three types of colonies have been observed (1) Dark, button-like, concentrically ringed colonies possessing a strong, greenishmetallic sheen so characteristic for Eccherichia coli. (2) Colonies with dark, purphish, wine-colored centers surrounded by a light pink zone. Some colonies are concentrically ringed. (3) Pink colonies with no suggestion of sheen but sometimes concentrically ringed.

Indole may or may not be formed Nitrites produced from nitrates

Fermentation of glucose: The end products characteristic for the genus Lischerichina are formed. Carbon dioxide and hydrogen gases are formed in approximately equimolar proportions (gas ratio 11) besides agnificant quantities of ethyl alcohol, and acetic, lactic and succinic acids with only traces of formit acid. Acetylmethylcarbinol and 2-3 butylene glycol have not been found (Voges-Proskauer test negative).

(Voges-Proskauer test negative).
Salts of citric acid are utilized as a sole source of carbon.

Catalase produced.

Hydrogen sulfide not detected in proteose peptone ferric-citrate agar.

Acid or acid and gas produced from xylose, arabinose, rhamnose, glucose, fructose, mannose, galactose, lactose, maltose, trehalose and mannitol. No acid or gas from melezitose, amygdalin and erythritol. Sucrose, raffinose, cellohiose, a-methyl-glucoside, adonitol, dulcitol, glycerol, inositol, sorbitol, starch, aesculin, salicin and sodium malonate may or may not he fermented. Aerobic, facultative.

Temperature requirements: Growth at 10°C and at 45° to 46°C. Optimum growth temperature 30° to 37°C. Gas not produced in Eijkman tests, although some cultures show growth at 45° to 46°C.

Salt tolerance: Most oultures ferment glucose in the presence of sodium chloride in a concentration of 0.0 to 70 per cent. A few cultures tolerate 8.0 per cent sodium chloride.

pH range: Optimum about pH 7.0. Growth occurs at pH 5.0 to pH 8.0.

Habitat: Normally found to a varying erree in soil, water and in the intestinal mad of man and animals. Widely distributed in nature.

Appendix: The following described species have been placed in Escherichio armsy belong here:

Emilias cicalescens Ford. (Ford, Benies Iron the Royal Victoria Hosp, Manual, I, St. 1903, 37; also see Jour. Mallon, I, St. 1904, 211; not Bocillus Calentia Arbers, Lancet, 194, 1918, 98, Lauretti Arbers, Bargey et al., 98, Lauretti Arbers, Bargey et al., 98, Lauretti Arbers, Bargey et al., 98, Lauretti Arbers, Bargey et al.,

nefastellani. (Cascas Abt., Orig., 65, netasiaticus Saks, 1893, 550; ani and Chalmers, Manual of Trop. Med., 3rd ed. 1919, 940; Proteus asiaticus Bergye et al. Manual, 1st ed., 1923, 211; Bacterium asioticum Weldin and Levine, Abst. Bact., 1, 1923, 13.) From faces. Ferments lactose slowly or not at all.

Bacillus asiaticus mobilis Castellari (Valérie 21, Boycott, Jour. Hyg., 6, 1906, 33 Castellari, Ann. di Med., Nav. e Colon., 11, 1916, 433; Salmonella asiaticus mobilis Castellari and Chalmers, Manual of Trop. Med., 3rd ed., 1919, 940; Bacterium palerici Weldin and Levine, Abs. Bact., 7, 1923, 13; Proteus valerici Bergy et al., Manual, 1st ed., 1923, 211.) From feces. A motile variety which Alves (Jour. Path. and Bact., 44, 1937, 483) found to he identical with Bacillus asiaticus.

Bacillus chylogenes Ford. (Ford, Studies from the Royal Victoria Hosp., Montreal, 1, (5), 1903, 62; also see Jour. Med. Res. 6, 1901, 219.) From fees.

Med. Res., 6, 1901, 219.) From feces. Bocillus coli immobilis Kruse. (Kruse, in Flogge, Die Mikroorganismen, 3 Auß, 2, 1896, 339; Bacterium coli immobilis Chester, Del. Agr. Exp. Sta., 9th Ann. Rept., 1897, 128; Enteroides enterious Castellani, Jour. Hyg., 7, 1907, 1; Bacillus schofferi MacConkey, Jour. Hyg., 9, 1993, 86; not Bocillus schafferi von Freudenreich, Landwirtschl. Jahrh. den Schweiz, 4, 1890, 17; Bacillus entericus Castellani and Chalmers, Manual of Trop. Med., 1st ed., 1910, 990; not Bacillus entericus Ford, Studies from Royal Victoria Hosp., Montreal, 1, (5), 1903, 40; Escherichia schoefferi Bergey et al., Manual, 1st ed., 1923, 196; Baclerium coli var. immobilis Winslow et al., Jour. Bact., 4, 1919, 486; Baclerium schafferi Weldin and Levine, Abst. Bact., 7, 1923, 13; not Bacterium schafferi Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 74; Escherichia enterica Weldin, Iowa State Coll. Jour. Sci., 1, 1927, 134.) From feces. These were all described as non-motile variants of Escherischia coli (see Weldin, loc.

cit.)

Bacıllus coli mutabilis Neisser.

(Neisser, Cent. f. Bakt., I Abt., Ref. (Supp.), 58, 1906, 98, Bacterium cols mutabile Massini, Arch f. Hyg , 61, 1907, 250; Escherichia coli mutabilis Castellani and Chalmers, Man. Trop Med , 3rd ed., 1919, 943; Escherichia coli-mutabile Deere et al., Jour. Bact , 31, 1936, 625 ) From feces. An unstable variant closely related to Escherichia coli characterized by irregular lactose fermentation When cultured on lactose indicator agar, it appears not to ferment lactose. After some days, lactose-fermenting papillae appear growing on or out of the original colonies. Subcultures from these seeondary colonies give typical lactose fermentation but subculture from the primary colony, avoiding contact with the papillae, gives delayed fermentation of lactose and when again plated will produce non-fermenting colonies on which fermenting papillae later appear

Bacilius gastricus Ford (Ford, Studios from the Royal Victoria Hosp, Montreal, 1, (5), 1903, 58, also see Jour Med. Res., 6, 1901, 213; Escherichia gastrica Bergey et al., Manual, 1st ed.,

gastrica Bergey et al , Manual, 1st ( 1923, 203) From feces.

Bacillus gruenthalı Morgan. (Das gruenthaler Bacterum, Fischer, Zische I Ilyz. 52, 1902, 417; Morgan, Brit. Med Jour., 1, 1903, 1257; Bacillus acids lactică var. gruenthalı Levino, Jour Bact., 5, 1918, 270; Bacterium acidiactics var. gruenthali Winslow, Kilgler and Rothborg, Jour. Bact., 4, 1919, 485; Eccherichia gruenthali Castellani and Chalmers, Manual of Trop. Med., 1919, 912, Bacterium gruenthali Weldin and Lovine, Abst. Bact., 5, 1923, 13) From feces.

Banllus thecus Ford. (Ford, Studies from the 10yal Veteria (Inosp., Montreal, I, (5), 1903, 61; also see Jour Med Res., 6, 1901, 213, Lischerichis theus Bergey et al., Manual, 1st ed., 1923, 203, Proteus thacus Bergey et al., Manual, 4th ed., 1931, 303.) From feces.

Bacillus infrequent Ford (Ford, Studies from the Royal Victoria Hosp., Montreal, 1, (5), 1903, 42; also see Jour. Med. Res , 6, 1901, 219.) From feces.

Bacillus jejunales Ford. (Ford, Studies from the Royal Victoria Hosp, Montreal 1 (5) 1002 Co. - leave 1 (5)

lepors Lethalis Sternberg, Manual of Bacteriology, 1893, 453; Bacterum leporis lethalis Chester, Ann. Rept. Del Col. Agr Exp. Sta. 9, 1807, 97; Migula, Syst. Bakt. 2, 1900, 651; Eberthella leporis Bergey et al., Manual, 1st ed., 1923, 220; Ebcherichia leporis Bergey et al., Manual, 2nd ed., 1925, 221.] From feces.

Bacillus para-gruenthali Castellani, (Castellani, 1914, quoted from Castellani and Chalmers, Ann. Past. Inst., 34, 1920, 614; Escherichia paragruenthali Castellani and Chalmers, Manual of Trop. Med, 3rd ed., 1919, 942; Bacterium coli var. paragruenthali Weldin and Lovine, Abst. Bact., 5, 1923, 13.) From feees. Weldin and Levine (Iowa State Coll. Jour. Sci., 1, 1926, 132) regard this species as identical with Bacillus gruenthali Morgan.

Bacillus plebeius Ford. (Ford, Studies from the Royal Victoria Hosp., Montreal, I, (5), 1903, 41; also see Jour. Med. Res., 6, 1901, 213; Ezcherichia plebeia Bergey et al., Manual, 1st ed., 1923, 203.) From feces.

Bacillus subalcalescens Ford. (Tord, Studies from the Royal Victoria Hosp., Montreal, 1, (5), 1903, 37, also see Jour. Med Res., 6, 1901, 217.) From feces.

Bacillus subgastricus Ford. (Ford, Studies from the Royal Victoria Hosp, Montreal, 1, (5), 1903, 55; also see Jour. Med Res, 0, 1901, 210-) From fects.

Bacillus vékanda Castellani (Castellani, Jour. Trop. Med and Hyg., 20, 1917, 181; Enteroider selanda Castellani and Chalacers, Manual of Trop. Med., 3rd ed., 1919, 911; Bacterium rekenda Weldin and Levine, Abst. Bact., 7, 1923, 13; Etcherichia vélanda Bergey et al., Manual, 1st ed., 1923, 197.) From feces. Bacillus exicultyformas Ilcarici.

(Henrici, Arb. Bakt, Inst. Hochseh. Karlsruhe, 1, 1894, 25; Escherichia vesiculiformans Bergey et al., Manual, 2nd ed., 1925, 222.) From cheese.

Bacterium chymogenes Ford. (Ford. Studies from the Royal Victoria Hosp., Montreal, 1, (5), 1903, 63; also see Jour. Med. Res., 6, 1901, 219.) From feees.

Bactersum coli alcaligenes Chiari and Loffler, (Cent f. Bakt., I Abt., Orig., 96, 1925, 95.) From feees.

Bacterium coli anindolicum Lembke (Lembke, Arch. f. Hyg, 26, 1896, 299; Bacillus anindolicum Chester, Man. Determ. Bact , 1901, 207; Escherichia anindolica Bergey et al., Manual, 3rd ed. 1930, 325.) From feces

Bacterium coli imperfectum Roeleke. (Cent. f. Bakt , I Abt., Orig , 145, 1939, 109.) From feces Lactose not fer-

mented.

Bacterium formicum Omelianska (Omelianski, Cent f. Bakt., II Abt., 11, 1904, 184; Achromobacter formicum Borgey et al , Manual, 1st ed , 1923, 144, Escherichia formica Bergey et al., Manual, 2nd ed , 1925, 220.) From soil,

Bacterium galactophilum Ford. (Ford, Studies from the Royal Victoria Hosp , Montreal, 1, (5), 1903, 39, also see Jour. Med. Res., 6, 1901, 217; Escherichia galactophila Bergey et al., Manual, 1st ed., 1923, 202 ) From feces.

Bacterium succinicum Sakaguehi and (Cent. f. Bakt , II Abt , 101, 1940,

341.) From cheese

Bacterium uromutabile Koch f. Bakt., I Abt , Orig , 133, 1935, 209 ) From genito-urinary infections lactose-fermenting variety that developed the ability to ferment lactose slowly.

Bacterium vesiculosum Henriei (Arb bakt. Inst Karlsruhe, 1, Heft 1, 1894, 37; Bacillus resiculosus MacConkey, Jour Hyg, 9, 1909, 86, Escherichia vesiculosa Castellani and Chalmers, Man Trop. Med . 3rd ed . 1919, 912 ) From cheese

Escherichia alba Sehrire (Trans Royal Soc. So. Africa, 17, 1928, 43.) From feces.

Escherichia braziliensis Mello. (Sao Paulo Medico, Anno 10, 2, 1937, 11.) From feces.

Escherichia colofoetida (Castellani) Handuroy et al. (Bacillus colofoetidus Castellani, Jour. Trop. Med and Hyg., 1930, 134; Hauduroy et al., Diet. d. Bact. Path., 1937, 226.) From feccs.

Escherichia coloides (Castellani) Castellani and Chalmers. (Bacillus coloides var. A and Bacillus coloides var. B, Castellani; Castellani and Chalmers, Manual of Trop Med, 1919, 942 and 946.) From faces.

Escherichia colotropicalis (Castellani) Castellani and Chalmers (Bacillus colotropicalis Castellani, 1007; see Castellani and Chalmers, Manual of Trop, Med., 3rd ed., 1919, 942 and 046) From feces.

Escherichia ellingeri (Motalnikov and Chorine) Bergey et al (Coccobacillus ellinger: Metalnikov and Chorine, Ann. Inst. Past., 42, 1928, 1635; Bergey et al., Manual, 3rd ed., 1930, 330) Causes fatal infection in insects as Pyrausta nubilalis Hubn. (European corn borer) and Galleria mellonella L. (bee moth). See Manual, 5th ed., 1939, 606 for a description of this species.

Escherichia khartoumensis (Chalmers and Macdonald) Hauduroy et al. (Bacillus kharloumensis Chalmers and Macdonald, 1915; see Castellani and Chalmers, Manual of Trop. Med., 3rd ed., 1919, 943; Enteroides khartoumensis Castellani and Chalmers, tbid., 941; Hauduroy et al., Dict. d. Bact. Path., 1939, 230) From feces.

Escherichia metacoli (Castellani) Castellani and Chalmers. (Bacıllus metacoli Castellani, 1915, see Castellani and Chalmers, Manual of Trop. Med., 3rd ed., 1919, 942 and 948.) From feces.

Escherichia metacoloides (Castellani) Castellam and Chalmers. (Bacillus metacoloides Castellani; see Castellani and Chaimers, Manual of Trop. Med, 3rd ed , 1919, 942 and 950 ) From feces.

Escherichia parodoxa (Toumanoff) Hauduroy et al. (Colibacilius parodoxus Toumanoff, Bull. Soc. Centr de Méd Vétér, 80, 1927, 367; Hauduroy et al, Dect. d. Baet. Path., 1937, 231) From feces.

Escherichia paioenterica (Castellani) Hauduroy et al. (Bocillus paraentericus Castellani, Manual of Trop Med. 1st ed., 1910, 991; Enteroides paraenterica Castellani and Chalmers, ibid., 3rd ed. 1919, 941; Hauduroy et al., Diet d. Bact Path., 1937, 231.) From feces

Escherichia pouloensis Mello (Ass Paulista de Medicina, 11, 1937, 73.) From feces.

Escherichia pseudocoli (Castellani) Castellani and Chalmers (Becillus) pseudo-coli Castellani, Manual of Trop Med , 1st ed., 1910, 990, Castellani and Chalmers, Manual Trop Med , 3rd ed , 1919, 942.) From feces.

Escherichia pseudo-coliformis (Castel lani) Hauduroy et al. (Bacillus pseudo-coliformis Castellani, 1917; see Castellani and Claimers, Manual of Trop Med, 3rd ed, 1919, 952; Hauduroy et al, Dict. d Bact. Path, 1937, 233.) From feees

Escherichio pseudocoloides (Castellani)

Castellani and Chalmers. (Bacillus pseudocoloted Castellani, 1916; see Castellani and Chalmers, Manual of Trop. Med., 3rd ed., 1919, 954; ibid., 912; Bactruum pseudo-coloides Weldin and Levune, Abst Baet., 7, 1923, 13.) From feces.

feces. Escherichia pseudocoscorobo Castellani and Chalmers. (Bacillus coscoroba Mac-Conkey, Jour Hyg, 6, 1906, 570; not Bacillus coscoroba Trétrop, Ann. Inst. Past , 14, 1900, 224; Bacterium coscorobae Bergey and Deehan, Jour. Med. Res . 19, 1908, 182, Castellani and Chalmers. Man Trop Med , 3rd ed., 1919, 912; Bacillus communior var. coscoroba Winslow. Kligler and Rothberg, Jour. Bact . 4, 1919, 486, Escherichia coscoroba Weldin, Ious State Coll. Jour. Sci. 1. 1926, 139) From feces and sewage. This organism described by MacConkey is quite different from the organism described by Tretrop (see Pasteurella appendix)

Echerichia pseudodysenteriae Bergey et al (Bacterium pseudodysenterioc Kruse, Deutschle Med Wohnschr., 27, 1901, 396, Bergey et al., Manual, 1st ed., 1923, 198.) From feces of normal persons and of dysentery patients

in) and or dysentery patient

### Genus II. Aerobacter Beijerinck \*

(Beyerinck, Cent. f Bakt, II Abt, 6, 1900, 193, Aerogenesbacterium Orla-Jensen, Jour. Bact., 6, 1922, 272, Colobactum (in part) Borman, Stuart and Wheeler, Jour. Bact, 48, 1944, 357 ) From Latin, air or gas, and rod

Short rods, fermenting glucose and lactose with acid and gas production. Methyl red test negative, Voges-Proskauer test positive. Form two or more times as much carbon dioxide as hydrogen from glucose, trimethyleneglycol not produced from glycerol by anaerobic fermentation, citric acid and salts of citric acid utilized as sole source of carbon. Grow readily on ordinary media. Pacultative anaerobes Widely distributed in nature.

The type species is Aerobacter acrogenes (Kruse) Beijerinck

Levine (Amer Jour Pub Health, 7, 1917, 781) who reports that the two characters do not correlate perfectly. Griffin and Stuart (Jour Bret., 49, 1910, 1931), find a similar correlation of characters but feel that because these characters do not correlate perfectly, it would be better to combine the two species into a single species.

 Completely revised by Prof. M. W. Yale, New York State Experiment Station, Geneva, New York, Nov., 1938; further revision, July, 1913.

### Key to the species of genus Aerobacter.

- I. Glycorol fermented with acid and gas.
  - A. Gelatin not liquefied (rarely liquefied).
- Aerobacter acrogences.
   A. Gelatin liquefied.

1. Aerobacter aerogenes (Kruse) Beijerinck. (Bacterium lactis aeragenes Escherich, Fortschr. d. Mcd., 3, 1885, 515; Bacterium lactis Baginsky. Ztschr. f.

Bacterium lactis Baginsky, Ztschr. f. phys. Chem., 12, 1883, 437; not Bacterium lactis Lister, Quart. Jour. Micro. Sei., 13, 1873, 380; Bacterium aceticum Baginsky, ibid.; Bacillus lactantium Trevisan, I generi e le specie delle Batteriacee, 1889, I5: Bacillus lactis aerogenes Sternberg, Manual of Baeteriology, 1893, 447; Bacillus aerogenes Kruse, in Flügge, Die Mikroorganismen, 2, 1896, 340; not Bacillus aeragenes Miller, Deutscho med. Wehnsehr., 12, 1886, 119; Bacterium aerogenes Chester, Del. Agr. Exp. Sta., 9th Ann. Rept., 1897, 53; not Bacterium aerogenes Miller, loc. cit.; Beijerinek, Arch, néerl, d. sci. exact, et nat., 4, 1900, 1; Encapsulatus lactis-acrogenes Castellani and Chalmers, Manual of Trop. Med., 1919, 934, (Encapsulata) Bacillus aerogenes Perkins, Jour. Inf. Dis., 37, 1925, 254; Colobactrum aerogenes Borman, Stuart and Wheeler, Jour. Bact., 48,

1944, 358.) From Latin, gas-producing.
Rods: 0.5 to 0.5 by 1.0 to 20 micross,
occurring singly. Frequently capsulated. (A variety showing a transverse
arrangement of the capsule has been
named Aerobacter transcapsulatus by
Thompson, Jour. Bact., £8, 1934, 41.)
Usually non-motile. Gmm-necative.

Gelatin colonies: Thick, porcelainwhite, opaque, moist, smooth, entire. Gelatin stab: Tbick, spreading, white,

apaque surface growth. No liquefaction.

Agar colonics: Thick, white, raised,
moist, smooth, entire. More convex
than colonics of Escherichia coli and aften
mucoid.

2. Aerobacter cloacac.

Agar slant: Abundant, thick, white, maist, glistening, spreading growth.

Broth: Turbid, with pellicle and abundant sediment.

Litmus milk: Acid with coagulation, Na pentonization.

Potato: Thick, yellowish-white to yellowish-brown, spreading with nodular autgrowths over the surface.

Indole may or may not be formed (Ford, Studies from the Royal Victoria Hospital, Montreal, 1, 1901-1903, 16; Bardsley, Jour. Hyg. (Eng.), 34, 1334, 33; Wilson, Med. Res. Council, London, Spec. Rept. Scr. 206, 1935, 161).

Nitrites produced from nitrates.

Methyl red test negative (Clark and
Lubs, Jour. Inf. Dis., 17, 1915, 160);
Vages-Proskauer test positive (Durham,
Jour. Exp. Med., 6, 1901, 373); inverse
correlation between methyl red and
Vages-Proskauer tests (Levine, Jour.

Bact., 1, 1916, 153).

Citric acid and salts of citric acid utilized as sole source of carbon (Koser, Jour. Bact., 8, 1923, 493).

Uric acid utilized as sole source of nitrogen (Koser, Jour. Inf. Dis, 53, 1918, 377).

Gas ratio: Two or more volumes of carbon dioxide to one of hydrogen formed from glucose (Harden and Walpole, Proc. Ray. Soc. Series B, 77, 1905, 399; Rogers, Clark and Davis, Jour. Inf. Dis., 14, 1914, 411).

Catalase produced.

Hydrogen sulfide not produced in pertone iron agar (Levine, Epstein and Yaughn, Amer. Jour. Pub. Heatth, 24, 1934, 505; Tittsler and Sandholter, Amer. Jour. Pub. Health, 27, 1937, 1240). More sensitive indicators give positive tests for hydrogen sulfide (Hunter and Weiss, Jour. Bact., 55, 1938, 20).

Trimethyleneglycol not produced from glycerol by anaerobic fermentation (Braak, Onderzoekingen over Vergsting van Glycerine, Thesis, Delft, 1928, 212; Werkman and Gillen, Jour. Bact , 25, 1932, 167).

Sodium hippurate hydrolyzed (Hajna and Damon, Amer. Jour. Hyg., 19, 1934, 545).

Acid and gas from glucose, galactose, lactose, fuctores, artifinose, cellobiose, salicin, esculin, starch, dextrin, glycerol, manniol, sorbitol and innesitol, a-rectbyl-glucoside usually fermented (Koser and Saunders, Jour. Bact., 24, 1932, 297). Sucrose, inulin, dulcitol and adouttol may or may not be fermented. Protopeetin not fermented. Variable fermentation of sucrose and mannitol (Sherman and Wing, Jour Bact., 53, 1937, 315).

Aerobic, facultative

Growth requirements: Good growth on ordinary laboratory media. Optimum growth temperature about 30°C. Grows bettor at temperatures below 30°C than does Escherickia coit. Usually destroyed in 30 minutes at 60°C, but certain heat-resistant strains may withstand this exposure (Ayers and Johnson, Jour Agr Res, 5, 1914, 401; Stark and Patterson, Jour. Dairy Sci., 19, 1903, 495). Gas not produced in Elijkmann test when carried out at 45° to 40°C (Elykmann, Cent. f. Bakt., I Abt., Orig., 37, 1904, 74; Levine, Epistein and Vaughn, Amer. Jour. Pub. Health, 24, 1934, 505)

Habitat: Normally found on grains and plants and to a varying degree in the intestinal canal of man and animals. Widely distributed in nature.

2. Aerobacter cloacse (Jordan) Bergey et al. (Bacillus cloacae Jordan, Rept. Mass. State Bd. of Health, Part II, 1830, 836; Bacterium cloacae Lehmann and Neumann, Bakt. Diag, 1 Aufl., £, 1836, 239, Bacillus lactie cloacae Conn, Esten and Stocking, Storrs Agr. Evp. Sta., Conn., 18th Ann. Rept for 1906, 180; Cloaca cloacac Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 938; Bergey et al., Manual, 1st ed., 1923, 207.) From Latin cloaca, sewer.

The following are also regarded as identical with Aerobacter cloacae: Aerobacter injurgaciens Grimes and Hennerty, Sci. Proc. Royal Dubin Society, (N. S.) 29, 1931, 93; not Aerobacter injurgaciens Beyerinck, Cent. f. Bakt., II Abt., 6, 1900, 199 (monotruchous); Bacullus levans Wolffin, Arch. f. Hyg., 21, 1894, 279 and Lehmann, Cent. f. Bakt., 16, 1891, 350 (Bacterium Levans Lehmann and Neumann, Bakt. Diag., 1 Aufi., 2, 1896, 235; Cloaca Levans Castellani and Chalmers, Man Trop. Med., 3rd ed., 1910, 933; Aerobacter levans Borgey et al., Manual, lat ed., 1923, 203).

Rods 0 5 to 1 0 by 1.0 to 2.0 microns, occurring singly. Usually motile possessing peritrichous flagella. Not capsulated Gram-negative.

Gelatin colonies: Thin, circular, hluish, translucent.

Gelatin stab: Slow liquefaction. Liquefying power sometimes lost (Kligler, Jour. Inf. Dis, 15, 1914, 199).

Agar colomes: Circular, thick, opaque with white conter, entire.

Agar slant: Porcelain-white, smooth, . glistening, spreading growth.

Broth: Turbid, with thin pellicle. Litmus malk: Acid, coagulation, gas.

slow peptonization.
Potato: Growth yellowish, moist, glistening.

Indole not formed (Levine, Epstein and Vaughn, loc. cit.; Wilson, Med. Res. Council, London, Spec. Rept. Ser. 206, 1935, 161).

Nitrites produced from nitrates.

Methyl red test negative; Voges-Pros-kauer test positive.

Citric acid and salts of citric acid utilized as sole source of carbon (Koser, Jour. Bact., 8, 1923, 493).

Urie seid utilised as sole source of

nitrogen (Koser, Jour. Inf. Dis, 23, 1918, 377).

Gas ratio: Glucose fermented with at least two volumes of earbon dioxide to one of hydrogen (Rogers, Clark and Davis, Jour. Inf. Dis., 14, 1914, 411).

Catalase produced.

Hydrogen sulfide not produced in peptone iron agar (Levine, Epstein and Vaughn, Amer Jour. Pub Health, 24, 1934, 595).

Sodium hippurate not hydrolyzed (Hajna and Damon, Amer. Jour. Hyg., 19, 1934, 545).

Acid and gas from glucose, fructose, galactose, arabinose, xylose, lactose, maltose, rafinose, dextrin, salicin, tre-halose, mannitol, sorbitol, cellobioso and a-methyl-glucosido. Sucrose usually fermented. Inulin, esculin, starch, dulcitol, rhamnose and protopectin not attacked. Glycerol fermented with no visible gas (Kligler, loc cit, 187; Levine, Amer. Jour. Pub. Health, 7, 1917, 784). Starch rarely fermented (Levine, tbd.). See Winslow, Kligler and Rothberg, Jour. Bact, 4, 1919, 429 for review of literature.

Focal odor produced.

Acrobic, facultative.

Growth requirements Good growth on ordinary laboratory media. Optimum growth temperature 30° to 37°C. Gas not produced in Eijkmann test when carried out at 45° to 46°C (Levine, Epstein and Vaughn, loe cit.).

Habitat · Found in human and animal feces, sewage, soil and water.

Appendix: The following described species have been placed in Aerobacter or may belong here:

Actinobacter polymorphus Duclaux (Duclaux, Ann. Inst Nat. Agron., 5, 1882, 110; Bacillus actinobacter Migula, Syst d Bakt, 2, 1900, 689) Causes swelling of cheese. Possibly this was Aerobacter cloaces.

Aerobacter chinense Bergey et al. (Bacillus capsulatus chinensis Hamilton, Cent. f. Bakt, II Abt., 4, 1898, 230;

Bacterium chinense Migula, Syst. d. Bakt., 2, 1900, 357; Bergey et al., Manual, 1st ed , 1923, 207.) From India ink.

Aerobacter decolorans Burkey. (Iowa State Coll. Jour. Sci., 3, 1928, 77.) From rotted potato and hay infusions.

Aerobacter diversum Burkey. (Iowa State Coll. Jour. Sci., 8, 1928, 77.) From soil.

Aerobacter faeni Burkey. (Iowa State Coll. Jour. Sci., 3, 1928, 77.) From hay influsions.

Aerobacter hibernicum Grimes and Hennerty. (Sci. Proc. Royal Dublin Society, (N.S.) 20, 1931, 92.) From butter.

Aerobacter leporis Botta. (Giorn. Batteriol. e Immunol, 28, 1939, 217.) From liver abscess in a rabbit.

Aerobacter melezitovorum Burkey. (Iowa Stato Coll. Jour. Sci., 3, 1928, 77.) From soil.

Acrobacter pectinovorum Burkey. (Iowa State Coll. Jour. Sci., 3, 1923, 77.) From creek water.

Acrobacter oxylocum (Trevisan) Bergey et al. (Bacillus oxylocus perutelesus Flugge, Die Mikroorganismen, 1886, 268; Bacillus oxylocus Trevisan, I generi ele specie delle Batteriacce, 1889, 17, Bacterium oxylocus pernicosus Chester, Ann. Rept. Del. Col. Agr. Exp. Sts., 9, 1897, 130; Bacterium oxylocum Migula, Syst. d. Bakt, 2, 1900, 394; Eschericha oxylocus Castellani and Chalmers, Manual of Trop. Med., 3rd ed., 1919, 912; Bergey et al., Manual, 1st ed., 1923, 208) From old milk.

Aerobacter paraoxylocum Mello. (Jorn. Dos Clinicos, No. 15, 1937.) From a dental abscess.

Bacillus aceris Edson and Carpenter (Edson and Carpenter, Vermont Agr. Exp Sta. Bull. 167, 1912, 475; Abromobacter aceris Bergey et al., Manual, 4th ed., 1934, 218.) From slimy maple sap See Manual, 5th ed., 1939, 506 for a description of this organism. Identified by Fabian (Ind. and Eng. Chem. 27, 1935, 349) as Aerobacter acrogenes.

Bacillus aromaticus Pammel (Pammel, Bull No. 21, Iowa Agr Eyper Sta, 1893, 792; Pammel and Pammel, Cent f Bakt., II Abt, 2, 1895, 633; Bacterum aromaticus Chester, Ann Rept Del Col Agr Exp. Sta, 9, 1897, 100, Flaobacterium aromaticum Bergey et al, Manual, 1st ed., 1923, 103) From cabbage Used as a starter for cheese making Aced and gas from glueose and sucrose See Manual, 5th ed., 1929, 533 for a description of this organism

Bacillus gunllebeau a, b and c, von Freudenreich (Ann de Micrographie, 2, 1890, 353.) From mastuts milk Culture a may well have been Aerobacter aerogenes, b appears to have been A cloacae while c was a nucoid variant (see Stornberg, Man. of Bact, 1893, 725)

Bacillus subcloacae Ford (Studies from the Royal Victoria Hosp, Montreal, 1, (5), 1903, 60; also see Ford, Jour Med Res, 6, 1901, 213) From feces

Bacterium liquefaciens Ford (Studies from the Royal Victoria Ilosp, Montreal, 1, (5), 1003, 59; also see Ford, Jour Med Res , 6, 1001, 215) From feecs While Ford regards this species as identical with Bactilus liquefacient Eisenberg, neither is adequately described and they differ in Important characters. The same holds truo for Bactilus haye/access

Fuller and Johnson, Jour. Exp Med., 4, 1899, 627.

Bacterium morgarilaceum Migula. (Perlachunthacillus, Maschek, Bakteriol. Untersuch. d. Lettmeritz Trinkvasser, Leitmeritz, 1887; Migula, Syst. d. Bakt., 2, 1900, 422 and 1059) From water. Possibly identical with Aerobacter aerocenes.

Bacterium subliquefaciens Ford. (Studies from the Royal Victoria Hosp., Montreal, 1, (5), 1903, 59; also see Ford, Jour Med. Res., 6, 1901, 219.) From feces

Bacterium zeac Comes. (Bacterial Diseases of Corn, Burrill, Ill. Agr. Exp. Sta Bull. 6, 1889, 164, Comes, Oriticgamia Agraria, 1, 1891, 500; Bacillus secalts Ludwig, Lelirbuid er niederen Kryptogamen, 1892, 95, Bacillus zeac Russell, Bacteria in their relation to vegetable tissue, Thesis, Johns Hopkins Chriv, Baltimore, 1892, 36) Prom corn blight. Moore (Agrie Sci. 8, 1891, 368) identified a culture received from Burrill as Bacillus classes, Jordan.

Burkey (Iona State College Jour. Ser. 5, 1923, 77) described five species (Ierobacter undalogenes, Ierobacter motorium, Aerobacter mitificans, Aerobacter salicianosaum and Jerobacter pseudoproteir pseudoproteir bacter classes which are regarded as varieties of Ierobacter classes.

## Genus III Klebslella Treusan.\*

(Trevisan, Atti della accad Fisio-Medico-Statistica in Milano, Ser 4, 5, 1885, 105; Caljunmalobacterium Aragão and Vianno, Mem Inst Oswaldo Cruz, 4, 1912, 222; Emcapuidus Castellam and Chalmers, Man Trop Med, 3rd ed, 1919, 931.) Named for Edwin Klobs (1831-1913), early German bacteriologist

Short rods, somewhat plump with rounded ends, mostly occurring singly. Encapsulated in the mucoid phase Non motile Gram-negative. Fermentation reactions are highly sarrable but usually a number of earlibulytates are fermented. Nitrites are produced from nitrates Aerobie, growing well on ordinary culture media. Encountered frequently in the respiratory, intestinal and genuto-unnary tracts of man, but may be robated from a variety of animals and materials.

The type species is Klebstella pneumomae (Schroeter) Trevisan.

Rearranged by Prof. M. W. Yale, New York State Experiment Station, Geneva, New York, Nov., 1938, further revision by Dr. O. B. Chapman, Syricuse Medical College, Syrause, New York, December, 1915

1. Klebsiella pneumoniae (Schroeter) Trevisan. (Pneumoniccoccus, Friedlaender, Arch. f. Path. Anat., 87, 1882. 319; Bacterium pneumonie crouposae Zopf, Die Spaltpilze, 3 Aufl., 1885, 66: Klebsiella crouposa Trevisan, Atti della Accad. Fisio-Medico-Statistica in Milano, Ser. 4, 3, 1885, 105; Hyalococcus pneumoniae Schroeter, in Cohn, Kryptogamen Flora von Schlesien, 3(1), 1886, 152; Bacillus pneumoniae Flügge, Dio Mikroorganismen, 2 Aufl., 1886, 204: Trevisan, Rend. d. R. Istit, Lombardo, Ser. 2, 20, 1887, 91; Klebsichla friedlanderi Trevisan, I generi e le specie delle Batterincee, 1889, 26; Bacillus mucosus capsulatus Paulsen, Mittheil. f. d. Verein Schleswig-Holsteiner Aerzte, 2, 1893. No. 7; Bacterium pneumoniae Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 200; Bacterium pneumonicum Miguln, Syst d Bakt., 2, 1900, 350; Bacillus friedlanderi Mace, Traité Pratique de Baet., 4th ed., 1901, 771; Encapsulatus pneumoniae Custellani and Chalmers, Mnn. Trop. Med., 3rd ed., 1919, 931; friedlanderi Coccobacillus Lemaire, Précis Parasitol. Hum., 5th ed , 1921, 20; Proteus pneumoniae Weldin, Iown State Coll. Jour. Ser., 1, 1926, 149: Bacterium friedlander Weldin, idem; Bacillus mucosus-capsulatus Mason and Beattie, Arch. of Internal Med., 42, 1928, 331.) From Greek, of pneumonia.

Rods. 0.3 to 0.5 by 5.0 microns, with rounded ends, often four to five times as long as broad, occurring singly and in pairs. Encapsulated Non-motile

Gram-negative.

Gelatin colonies: Dirty-white, smooth, opaque, entire, slightly raised.

Gelatin stab Dirty-white surface growth. Filiform growth in stab. No liquefaction. Gas bubbles

liquefaction. Gas bubbles
Agar colonies: White, shiny, convex,
smooth, glistening, entire.

Agar slant: Slimy, white, somewhat translucent, raised growth.

Broth. Turbid, with thick ring or film. Litmus milk: Variable. Potato: Yellowish, slimy, raised growth. Gas is formed.

Nitrites produced from nitrates.

Indole variable, usually not formed. Fermentation of carbobydrates highly variable. Acid and gas may be formed from glucose, lactose, sucrose, fructose, galactose, maltose, mannitol and inositol. Methyl red test variable.

Acetylmethylcarbinol production variable.

Blood sgar: Usually no bemolysis.

Utilization of citrate as a sole source of carbon variable.

Aerobic, facultative.

Optimum temperature 37°C.

Common name: Friedlander's pneumobacillus.

Source: Originally Isolated from sputum in pneumonia.

Habitat: Associated with infections of the respiratory, intestinal and genitourinary tracts of man. Encountered in infections of animals and may be isolated from a wide variety of sources.

Note: The difficulty experienced in distinguishing members of this genus from those of Escherichia and Aerobacter is recognized. The members of these three genera exist in at least three growth phases, nucoid (capsulated), smooth and rough.

Working with the mucoid phase of Klebsiella, Julianelle (Jour. Exp. Med., 44, 1926, 113, 683, 735; 58, 1930, 539) described three serological types, A, B and C on the basis of capsular specific polysaccharides. There is evidence that other types exist. The presence of a generic specific somatic antigen pottern has not been definitely accepted.

Appendix: The following organisms may be placed in Klebsiella. The evidence for differentiating them into distinct species is so meagre that for the present it may be better to consider them as varieties of Klebsiella pneument et al.

Klebsiella adanti Hauduroy et al.

(Dict. d, Bact. Path., 1937, 260.) From a case of pyelocystitis

Klebsiella capsulata (Sternberg) Bergey et al. (Kapselbacillus, Pfeiffer, Ztschr. f. Hyg., 6, 1889, 145, Bacıllus capsulatus Sternberg, Manual of Bact, 1893, 431; Bacterium capsulatum Migula, Syst d. Bakt., 2, 1900, 349, Encapsulatus pferfferi Bergey et al., Manual, 1st ed , 1923, 239; Bergey et al., Manual, 2nd ed., 1925, 265.) From purulent evudate from stomach of a guinea pig

Klebsiella crassa Trevisan (Bacıllus sputigenus crassus Kreibohm, Inaug Diss., Göttingen, 1889; abst in Cent. f. Bakt., 7, 1890, 313; Bacillus crassus sputigenus Flügge, Die Mikroorganismen, 2 Aufl., 1886, 260; Trevisan, I genera e le specie delle Batteriacee, 1889, 25; Bacterium sputigenes crassus Chester, Ann. Rept. Del. Col. Agr. Exp Sta, 9, 1897, 88; Bacterium crassum Chester, Man. Determ. Bact., 1901, 151 ) From sputum.

Klebsiella cunicul: Hauduroy et al (Bacillus capsulatus pyaemiae cuniculi Koppinayi, Ztschr f. Tiermed, 11. 1907, 429; Hauduroy et al , Diet d. Baet Path., 1937, 262.) From pleuropericarditis ln a rabbit.

Klebstella genitalium (Dimock and Eduards) Hauduroy et al (Encopsulatus genttalium Dimock and Edwards, Jour. Amer. Veter. Assoc., 70, 1927, 469; Hauduroy et al , Dict. d. Bact Path , 1937, 264.) From infections in the genlto-urinary organs of mares

Klebsiella granulomatis (Aragão and Vianna) Bergey et al. (Calymmatobacterrum granulomatis Aragão and Vianna, Mem. do Inst. Oswaldo Cruz, Rio de Janeiro, 4, 1912, 211: Encapsulatus inquinalis Bergey et al., Manual, 1st ed., 1923, 238; Bergey et al , Manual, 2nd ed , 1925, 264.) From granuloma inguinale.

Klebstella ozaenae (Abel) Bergey et al. (Bacillus mucosus ozaenae Abel, Cent. f. Bakt., 13, 1893, 167; Bacillus ozaenae Abel, ibid., 172; not Bacillus ozaenae Migula, Syst. d Bakt., 2, 1900, 645, 662, †Bacillus capsulatus mucosus Fasching, Sitzgsber, Wien, Akad., III Abt., 100, 1891 (Bacterium capsulatus mucosus Chester, Ann Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 130; Bacterium faschingii Mıgula, Syst. d. Bakt., 2, 1900, 355; Bacillus capsulatus-mucosus Holland, Jour. Baet , 5, 1920, 217; Bacterium mucosum capsulatum Holland, ibid., Bacterium mucosum-capsulatum Holland, 1bid., 217), Bacterium ozaenae Lehmann and Neumann, Bakt, Diag. I Aufl , 2, 1896, 201; Bacterium mucosus ozaena Chester, Ann. Rept. Del. Col. Agr. Exp. Sta , 9, 1897, 138; Encapsulata ozenae Bergey et al., Manual, 1st ed., 1923, 240; Bergey et al., Manual, 2nd ed., 1925, 206.) From cases of ozena.

Klebstella paralytica Cahn, Wallace and Thomas. (Wallace, Lyell, Thomas, Alvin and Cahn, Proc. Soc Exp. Biol., 29, 1932, 1908; Cahn, Wallace and Thomas, Science, 76, 1932, 385; Wallace, Calm and Thomas, Jour. Inf. Dis. 53. 1933, 386, Klebstella alcis Hauduroy et al Diet d. Bact. Path., 1937, 260.) From intestine of tick (Dermacentor albanicius) and thought to be the cause of

tick paralysis of moose.

Klebsiella rhinoseleromatis Travisan. (Rhinoscleromabacillus, v. Frisch, Wien. med Wehnsehr , 1882; Cornil, Progres Medical, 1883; Trevisan, Rend. d. R Istat Lombardo, Ser. 2, 20, 1887, 95; Bacterium rhinoscleromatis Migula, Syst. d Bakt . 2, 1900, 352; Bacterium nasalis Chester, Man. Determ. Bact., 1901, 131; Bacillus rhinoscleromatis Winslow, Kligler and Rothberg, Jour. Bact., 4, 1919, 491.) From eases of rhinoseleroma.

\*Appendix I. Tribe Eschericheae: Borman, Wheeler and Stuart (Jour. Bact., 48, 1944, 361) place coliform-like bacteria that are slow lactose-fermenters in a separate genus Paracolobactrum ns follows:

Genus A. Paracolobactrum Borman, Stuart and Wheeler,

(Paracolibacille, Widal and Nobecourt, Semaine Méd., 17, 1897, 285; Borman, Stuart and Wheeler, Jour. Bact., 48, 1944, 361.)

Short rods characterized by consistently delayed fermentation of lactose (occasionally negative). Glucose is fermented with formation of visible gas. Certain forms attack carbohydrates characteristically at 20° to 30°C but not at 37°C. Antigene relationships to other genera in the family are common, even with respect to major antigens.

The type species is Paracolobactrum aerogenoides Borman, Stuart and Wheeler.

Key to the species of genus Paracolobactrum.

- I. Acetylmethylenrbinol produced.
- II. Acetylmethylcarbinol not produced.
  - A. Citric acid utilized as a solo source of carbon. 2. Paracolobactrum intermedium
  - B. Citric acid not utilized as a sole source of carbon.
- Paracolobactrum aerogenoldes Borman, Stuart and Wheeler. (Pnra-aerogenes, Stuart, Wheeler, Rustigian and Zimmerman, Jour Bact., 45, 1943, 117; Borman, Stuart and Wheeler, Jour. Bact., 48, 1944, 361) Latinized, resembling aerogenes.

Characters us for Aerobacter gerogenes and Acrobacter cloacae except for consistently delayed fermentation of lactose. Source From human gastroenteritis.

Habitat Surface water, soils, grains, as well as the intestinal tract of animals, including man.

2 Paracolobactrum intermedium Borman, Stuart and Wheeler. freundii, Stuart et al , Jour Bact., 45, 1943, 117, Borman, Stuart and Whecler, Jour Bact , 48, 1944, 361.) From Latin intermedius, intermediate.

Characters as for Escherichia freundit. and Escherichia intermedium except for consistently delayed fermentation of lastose.

Source: From human gastroenteritis. Habitat Surface water, soil, grains, as well as the intestinal tract of animals, including man.

Paracolobactrum aerogenoides.

3. Paracolobactrum coliforme.

3. Paracolobactrum collforme Borman Stuart and Wheeler. (Pnm-coli, Stuart et al., Jour. Bact., 45, 1943, 117; Borman, Stuart and Wheeler, Jour. Bact., 48, 1944, 361.) Latinized, resembling coli Characters ns for Escherichia coli except for consistently delayed fermentation of lactose.

Source: From human gastroenteritis Habitat: Surface water, soil, grains, ns well as intestinal tract of animals, ineluding man.

Nore: The following also belong here: paracoli Stutzer and Bacterium (Non-lactose-fermenting Bac-Wantow. terium coli, Gilbert and Lion, Scmaine Med., 13, 1893, 130; Stutzer and Wsorow, Cent. f. Bakt., II Abt., 71, 1927, 115) From intestines of healthy larvae of a moth (Euxoa segetum).

Salmonella para-colon (Day) Haudurey et al. (Bacillus para-colon Day; see Castellani, Cent. f. Bakt., I Abt., Orig. 65, 1912, 264; nlso Castellani and Chalmers, Man Trop. Med., 3rd ed., 1919, 950; Hauduroy et al., Dict. d. Bact. Path., 1937, 461.)

\*Prepared by Dr. E. K. Borman, Bureau of Laboratories, State Department of

Health, Hartford, Connecticut, July, 1915

\*Appendix II. Tribe Eschericheae: Gram-negative, peritrichous to non-motile rods similar to organisms placed in *Paracolobactrum, Scratia* and Salmonella have recently been described as causing diseases of repulse, birds and mammals. They may be grouped here although they have been placed in several different genera

 Bacterium sauromall Conti and Crowley (Jour Bact, 56, 1938, 269)
 From a generic name of brands, Sauromalus.

Short rods 02 to 05 by 10 to 20 microns, with rounded ends, occurring in groups Motile with 4 to 6 peri-

trichous flagella Gram-negative Gelatin Infundibuliform liquefaction complete in 3 days at 37°C Black sediment Medium browned.

Agar slant. Growth abundant, spreading, convex, faint yellowish-green, glistening, smooth, translucent, butyrous Decided odor. Medium greened

Nutrient broth After I day at 37°C, moderate turbidity. Ring Decided odor Scanty floeculent sediment

Milk Alkalino and complete peptonization in ten days

Indole not formed

Potato Growth yellowish-green to olive.

Blood medium Complete alpha hemolysis in 48 bours

Peptone medium Slight fluoreseent greenish-yellow pigmentation

Nitrites produced from nitrates Ammonia is produced

Acid and gas from glucose, sucrose, maltose, galactose, fructose, sahein and mainitol. Acid but not gas from glycerol. No acid from lactose, arabinose, vylose, devtrin, inulin, dulcitol or starch

Hydrogen sulfide produced Catalase positive

Methyl red test positive Pathogenic for animals

Temperature relations Optimum

37°C Minimum 20°C Maximum 45°C Aerobic. Source From a tumor-like growth on

the chuckawalla (Sauromalux rarrus)

Habitat: Causes tumors in lizards

 Serratla anollum Duran-Reynals and Clausen. (Jour. Bact, 55, 1937, 369) From a generic name of lizards, Anolis.

Rods 0.2 to 0.4 by 1.0 to 2.0 microns, occurring singly, in pairs, in elusters and pulsiades Pleomorphie, other forms being 4 to 5 microns in length, eurved, occasionally glub-like, or 10 to 15 microns long and surrounded by a capsular material, or occasionally small and occus-like. Mottle (Durn.Reynals and Clausen) with 1 to 4 perturbous flagella (Bred) Non-acid-fast, Gram-hecutive.

Gelatin stab: Rapid growth Liquefaction infundabiliform. After 6 to 10 days a thick soft pellicle and blackish

sediment is formed.

Agar colonies: After 24 bours at 37°C, solated colonies are low, convex, margin entire or slightly indulate. Colonies amounts, and the same standard of the same translucent, butyrous, glistening, smooth, 10 to 25 mm in diameter. While some colonies retain their smooth character, others become larger, striated and wrinkled, showing opaque, radiated folds with irregularly cremated edges and a rougher texture. Penetrating acid smell produced.

Agar slant After 24 hours at 37°C, ahundant, confluent, mised, whitish, butyrous, glistening, with entire or undulate edges.

Broth Moderate growth with uniform turbidity. A pellicle is formed which disintegrates forming a ring on the walls of the tube. Sediment. Faint fluorescent vellowish coloration.

No visible gas in glucose broth (Breed) Peptone water After 6 to 10 days

marked turbidity, medium darkened, blackish seilment formed

Litmus milk Coagulation and digestion Partial discoloration of the litmus.

Prepared by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, June, 1946

Potato: Growth abundant, butyrous, glistening, raised, pinkish.

Indole not formed.

Blood is hemolyzed.

Loeffler's serum: Abundant, glistening growth. Liquefaction.

No H.S produced.

Ammonia is produced.

Although Duran-Reynals and Clausen report nitrites not produced from nitrates, a retest of their cultures by Breed has shown that nitrites are actively produced from nitrates.

Acid from glucose, fructose, sucrose, mannitol, maltose, galactose and salicin. Dextrin, lactose, inulin, dulcitol, xylose and arabinose slightly attacked or not at all.

Pigment production: Water-soluble pigment produced. Pink coloration best shown on glycerol potato. Reddish coloration best shown in peptone water with 2 per cent glucese, the yellow coloration in glucese broth and the black coloration in the sediment of liquefied golatin and peptone water. Some non-pigmented strains.

Temperature relations: Grows well at 20°C. Growth more abundant at 37°C. Practically no growth at 10°C. Thermal death point 60°C for 20 minutes.

Aerobic.

Pathogenicity: Pathogenic for amphibanas, reptiles and to some extent fish. Lesions are produced in the iguand lizards (Anolis equesirs and Anolis carolinensis), the gekkonid lizards (Tarentola mauritanca and Hemidactylus brookii), the garter snake (Thamnophis butleri) and the brown snake (Storeria dekayi), the musk tutle (Sterndharus odoratus), the toad (Bufo americanus), the free (Rana pipiens) and the cathsh (Ameiuras melas). When the inoculated animal is kept at 37°C, the disease becomes general and usually is fatal. Non-pathogenic for warm-hlooded animals (Clussen and Duran-Reynals, Amer. Jour. Path, 13, 1937, 441).

Source: From tumor-like lesions in Cuban lizards (Anolis equestris). Also isolated from iguanid lizards (Basiliscus sittatus) from Mexico by Clausen and Duran-Reynals (Ioc. cit.).

Habitat: The cause of a natural, nonlatal, contagious disease of lizards.

3. Salmonella sp. (Type Arizons). (Salmonella sp., Dar es salaam Type var. from Arizona, Caldwell and Ryerson,

zona culture, Edwards, Cherry and Bruner, Jour. Inf. Dis., 75, 1913, 236, Salmonella arizona Group, Edwards, Jour. Bact., 49, 1915, 513)

Ferments lactose and liquefies gelatia Antigenie structure: XXXIII: 24, 2n, 2x; -.

Source: Isolated by Caldwell and Ryerson (loc. cit.) from horned fixads,
Gila monsters and chuckawallas. Also
pathogenic for guinea pigs and rabbits.
Found in snakes by Hinshaw and
McNeill (Cornell Vet., 34, 1944, 218).
Also reported by Edwards (loc. cit)
from infants.

Habitat: Apparently widely distributed in lizards, snakes, and warmblooded animals.

#### TRIBE II. ERWINEAE WINSLOW ET AL.

#### (Jour. Bact., 5, 1920, 209.)

Motile rods which normally require organic nitrogen compounds for growth. Produce acid with or without visible gas from a variety of sugars. In some species, the number of carbon compounds attacked is limited and lactose may not be fermeted. May or may not liquefy gelatin. May or may not produce nitrites from nitrates Invade the tissues of living plants and produce dry necrosis, galls, withs and soft rots. In the latter case, a protopectionse destroys the middle hamellar substance.

There is a single genus

#### Genus I. Erwinla Winslow et al. \*

(Jour. Bact, 2, 1917, 560.) Named for Erwin F. Smith, pioneer American plant pathologist.

Characters as for the tribe.

The type species is Erwinia amylorora (Burrill) Winslow et al.

#### Key to the species of genus Erwinia.

- \*\*Pathogens which cause dry necrosis, galls or wilts in plants but not a soft rot (Erwinia sensu stricto).
  - A. Gas not produced in sugar media.
    - 1. Gelatin liquefied.
      - a. Starch not hydrolyzed.
        - b Nitrites not produced from nitrates.
          - 1. Erwinia amylovora.
        - bb. Nitrites produced from nitrates.
      - 2. Erwinia milletiae.
      - as. Starch hydrolyzed.
        b. Nitrites produced from nitrates.
        - 3. Erwinia vitivora.
      - sas. Action on starch not reported.
        - b. Nitrites produced from pitrates.
          4. Erwinia cassagae.
      - 2. Gelatin not liquefied.
        - a. Starch not hydrolyzed.
          - b. Nitrites produced from nitrates.
          - 5. Erwinia salicis.
            bb Nitrites not produced from nitrates.
          - 6. Erwinia tracheiphila,

<sup>\*</sup> Completely revised by Prof. P. D. Chester, New York, N. Y., December, 1938; further revision by Prof. Watter H. Burkholder, Cornell University, Ithaca, New York, May, 1945.

<sup>\*\*</sup> The gonus Lewina as defined here is heterogeneous in nature and is composed of at least two distinct groups. The first group constitutes Lewina proper and does not produce visible gas from sugars. Walder (fows State Coll. Jour. Sci., 19, 1915, 433) in a paper that appeared as this manuscript was ready for the press has suggested that the species in this first group be placed in a separate family Lewindezed.

- †Pathogens which normally cause a soft rot in plants (largely belong in the genus Pectobacterium Waldee).
  - A. Gas produced in sugar media.
    - Gelatin liquefied.
      - a. Nitrites produced from nitrates.
        - b. Hydrogen sulfide produced.
          - 7. Erwinia betivora
          - Erwinia carnegicana.
        - bb. Hydrogen sulfide not produced
          - Erwinia atroseptica.
             Erwinia carotovora.
      - aa. Nitrites not produced from nitrates.
        - 11. Erwinia erivanensis.
        - 12. Erwinia flavida.
    - 2. Gelatin not liquefied.
      - a. Starch hydrolyzed
- Erwinia dissolvens.
- aa. Starch not hydrolyzed.
- Erwinia nimipressuralis.
- B. Gas not produced in sugar media.
  - 1. Gelatin liquefied.
    - a. Nitrites produced from nitrates
      - b. Starch hydrolyzed.
- Erwinia ananas.
   Erwinia cytolytica.
- bb. Starch not hydrolyzed.
  - c. Acid from lactose.
- Erwinia aroideae.
   Erwinia mangiferae.
- ec. No acid from lactose.

  19. Erminia citrimaculans.
- 2. Gelatin not liquefied.
- 20. Erwinia rhapontici.
- 3 Very slow gelatin liquefaction.
- . . . . .
- Nitrites not produced from nitrates.
  - 21. Erwinia lathyri.
- C. Gas production not reported.
  - Gelatin liquefied.
    - a. Nitrites produced from mtrates.
      - 22. Erwinia lilii.

<sup>†</sup> The second group of species usually causes soft rots, but includes a few not very typical species. Waldee (loc cit.) has proposed that the species that cause typical soft rot be placed in a new genus, Pectobacterium, with Pectobacterium caroleorum as the type species. The new genus is retained in the family Enterobacteriaceae. Waldee would place the stypical species in other genera, Erunia dissolvers for example being placed in the genus Aerobacter. As further comparative studies are needed before such changes can be made with confidence, the older arrangement is allowed to stand in this edition of the Manual.

1. Ewinia amylovora (Burrill) Winslow et al. (Microcceus amylovorus Burrill, Illinois Indust. Univ., 11th Rept., 1822, 142; American Naturalist, 17, 1883, 310; Bacillus amylovorus Trevisan, I generi e le specie delle Batteriacee, 1889, 19; Bacterium amylovorus Chester, Del. Col. Agr. Evp. Sta., 9th Ann. Rept., 1897, 127; Bacterium daylovorum Chester, Manual Determ Bact., 1901, 176; Winslow et al., Jour., Bact., 5, 1920, 200.) From Latin, starch devouring

Description mainly from Ark, Phyto-

path , 27, 1937, 1.

Rods 0 7 to 1.0 by 0 9 to 1 5 microns, occurring singly, in pairs and sometimes in short chains. Motile with peritrichous flagells. Gram-negative.

Gelatin colonies: Circular, whitish,

amorphous, outire.

Gelatin stab: Slow crateriform liquefaction confined to the upper layer. Agar colonies: Circular, grayish-white,

moist, glistening, irregular margins
Broth. Turbid, with a thin granular

pelicio.

Potato: Growth white, moist, glistening. Medium not softened. No odor. No pigment.

Litmus milk: Congulated after 3 to 4 days to a pasty condition, with a separation of whey. At first acid, becoming alkaline. Litmus reduced. There is a gradual digestion of the casein

Blood serum Growth similar to that

on agar No fiquefaction.

Dunham's solution. Rapid growth, but clouding not dense

Indole not produced.

Nitrites not produced from nitrates Most of the strains gave a positive test for ammona in broth, a few showed only a slight positive test.

Acetylmethylcarbinol produced. Growth in synthetic media with (NH<sub>4</sub>)<sub>1</sub>HPO<sub>4</sub> as a source of nitrogen and containing different carbohydrates.

Acid without gas from glucose, sucrose, arabinose, mannose, fructose, maltose, cellobiose, raffinose, salicin and amygdalin. Xylose, rhamnose, dulcitol and starch not fermented. Acid production from lactose and galactose variable. Utilizes salts of citric, malic, and hipputric acid. Action on salts of lactic and successed and success and success and the concess and the control of the control

Asparagine fermented with production of alkalı Glycine, valine, isoleucine, glutamic acid, cystine, tyrosine, tryptophane and urea not fermented.

Minimum temperature between 3° and 8°C. Maximum below 37°C.

Optimum pH 68. Minimum pH 4.0 to 4.4. Maximum pH 8.8

Source: From the blossoms, leaves and twigs of the pear and apple.

Habitat Attacks a large number of species in several tribes of the family Rosaceae (Elliott, Manual Bact. Plant Pathogens, 1930, 19).

 Erwinia milletiae (Kawkami and Yoshida) Magrou. (Bacillus milletiae Kawkami and Yoshida, Bot. Mag, Tokyo, 34, 1920, 110, Magrout, in Hauduroy et al, Diet. d. Batt. Path., 1937, 213.)
 From Milletia, a genus named for A. J. Millett.

Rods: 04 to 06 by 09 to 25 microns Motile with peritrichous flagella. Capsules. Gram-negative.

Gelatin: Liquefaction begins after 8 days.

Agar colonies: Circular, flat, smooth, shiny, opaque, waxy yellow. Margins entire. Broth: Turbid. Heavy precipitate.

Milk No congulation. Clears with alkaline reaction.

Conjac. No liquefaction.

Natrites produced from nitrates

Acid but no gas from galactose, fructose, lactose, maltose, sucrove and mannitol. No acid from glycerol.

Starch not hydrolyzed.

Growth in 0.2 per cent but not in 0.3 per cent of the following acids in sucrose

peptone broth: Acetic, citric, exalic and tartaric.

Acrobic.

Grows well at 32°C. Thermal death point, 53°C for 10 min.

Source. From galls on the Japanese wisteris in various localities in Japan.

Habitat · Causes galls on the Japanese wisteria. Milletia floribunda.

3. Erwinia vituvora (Baccarini) du Plessis. (Bacillus viticorus Baccarini, Bull. della Soc. Bot. Ital., 1891, 235; du Plessis, Dept. Agr. and Forestry Union of S. Africa, Science Bul. 21t, 1910, 88) From Latin, devouring the vine

Note, Macchiati (Bol. della Soc. Bot., 1897, 156) uses the name Bacillus baccarinis for Bacillus ritirorus The description Macchiati gives is not of Erwinia vitivora but is evidently that of a saprophyte occurring with the patho-He conducted no inoculation experiments. Migula (System der Bakterien, 2, 1900, 778) gives Bacıllus retivorus Bace. (Malpighia, 6, 1892, 229) which is an incorrect citation and Bacillus baccarinii Maech 1897, as synonyms of Bacillus gummis Comes ISS4 It is impossible to determine what this latter species is. Du Plessis (loc. cit ) does not believe Bacillus aummis is the same as Erwinia vitivora.

Rods: 0.74 (0.44 to 1.10) by 1.46 (0.95 to 2.19) microns. Cells sometimes dumbbell-shaped. Motile with peritrichous flagella. Gram-negative. Capsules present.

Gelatin: Liquefaction

Agar colonies First punctiform, irregularly circular or lenticular, ultimately circular, raised to pulvinate, glistening, spreading, light to orange-yellow Agar becomes brown.

Broth: Turbid in 24 hrs. Whitish to

lemon yellow pellicle.

Milk: Litmus reduced. Thread-like to spongy eard formed. Yellow whey about curd Yellow gronth on top of plain milk. Medium acid. Uschinsky's solution: Slowly becomes turbid. Pellicle. Sediment whitishvellow.

Nitrites produced from nitrates.

Hydrogen sulfide produced.

Acid produced from glucose, fructose, xylose, lactose, sucrose, mannitol and salicin. No acid from raffinose or inulia Starch hydrolyzed.

Facultative anaerobe.

Temperature relations: Optimum 25°C Maximum 35° to 40°C. Minimum 5° to 10°C.

Optimum pH 6.0. Minimum 4.2. Source: Du Plessis used 5 isolates from various localities in South Africa

Habitat: Causes a disease of grape vines in South Africa, Italy and France.

 Erwinia cassavae (Handsford) comb nor. (Bacterium cassavae Handsford, Ann. Rept. Dept. Agric. Ugands for 1937, II, 1938, 48.) From cassava, the host plant.

Rods: Motile with a few peritrichous flagella No capsules. Gram-negative Gelatin is slowly liquefied.

Agar colonies: Smooth, lens shaped, edges entire, translucent and of uniform structure. Yellow.

structure. Yellow. Broth: Turbid with a ring. A yellow

precipitate in old cultures.

Milk becomes alkaline: Not cleared

Nitrates are rapidly reduced to m-

Methyl red test negative. Acetylmethylcarbinol produced (Dowson, Cent

f. Bakt., II Abt , 100, 1939, 183). Acid but no gas from glucose, sucrose,

maltose and glycerol, but not from he

Facultative anacrobe.

Source: From necrotic lesions on eassaya leaves in Uganda

Habitat: Pathogenic on cassava, Mani hot sp.

5. Erwinia salicis (Day) Chester. (Bacterium salicis Day, Oxford For. Mem., 3, 1924, 14; Phytomonas salicis

Magrou, in Hauduroy et al , Dict. d. Bact. Path., 1937, 408; Chester, in Bergev et al., Manual, 5th ed., 1939, 406.) From Latin salix, willow; M. L. generie name, Salix.

Description from Dowson, Ann. Appl Biol., 24, 1937, 542.

Rods · 05 to 07 by 08 to 2.2 microns, occurring singly or in pairs, rarely in chains, with rounded ends Motile with 5 to 7 long peritrichous flagella Gramnegative.

Gelatin stab: Beaded growth No. liquefaction.

Infusion agar: Colonies appear slowly,

circular, with slightly uneven margins, pale brown by transmitted light, pale gray by reflected.

Infusion agar slants: Growth thin,

nearly transparent. Broth: Moderate, uniform turbidity.

No pellicle. Litinus milk: No change.

Potato: Bright yellow, later fading to

pale brown, spreading, abundant, glistening, slimy growth.

Indole not formed.

Nitrates produced from nitrates (Dow-Hydrogen sulfide not produced.

Ammonia not produced

Acetylmethylcarbinol produced Methyl red test negative (Dowson, Cent f Bakt , 11 Abt., 100, 1939, 183).

Acid, but no gas, from glucose, galactose, mannose, xylose, maltose, sucrose, raffinose, glycerol, mannitol and sahein No growth in arabinose, fructose, rhamnose, inulin or destrin

No growth in Cohn's solution.

Starch not hydrolyzed. Temperature relations, Optimum 29°

to 30°C Minimum 5° to 10°C Maximum 33° to 37°C. Thermal death point 50° to 52°C. Aerobic, facultative anaerobic.

Source. From the cucket-bat willow (Salix caerulea) and from the white willow (Salix alba).

Habitat . Causes a water-mark disease of willow in England

6. Erwinla tracheiphila (Erw. Smith) Holland. (Bacillus tracheiphilus Erw. Smith, Cent f. Bakt., II Abt., 1, 1895, 361; Bacterium tracheiphilus Chester, Ann. Rept. Del. Col. Agr. Exp Sta., 9, 1897, 72; Smith, see Bacteria in Relation to Plant Diseases, 2, 1911, 286; Holland, Jour. Bact, 5, 1920, 215.) From Greek, trachea-loving, 1 c., live in fibrovascular bundles.

Rods: 05 to 0.7 by 1.2 to 2.5 migrons. with rounded ends, occurring singly and in pairs, more rarely in fours. Motile with peritrichous flagella. Capsulated. Gram-negative.

Gelatin colonies Small, circular, grayish-white, smooth, glistening. Show Internal strike by transmitted light.

Gelatin stab: Surface growth thin, spreading, grayish white. Slight filiform growth in depth No liquefaction. Agar colonies. Small, eircular, grayish-

white, smooth, glistening

Agar slant; Growth gray, smooth,

filiform, moist, glistening Broth: Slight turbidity. No ring or

pellicle. Potato: Growth white or color of substratum, smooth, moist, glistening. No action on the starch. Does not soften the middle lamella of potato cells.

Litmus milk. Not congulated. Reaction unchanged Litmus not reduced Not peptonized.

Egg albumen: Not digested.

Blood serum: No liquefaction Cohn's solution: No growth Uschinsky's solution; Weak growth

Fermi's solution: Weak growth. Indole not formed in Dunham's solution

Natrites not produced from nitrates. Ammonia production moderate.

Cannot utilize asparagine, ammonium lactate or tartarate as sources of nitrogen.

Acid without gas from glucose, sucrose and fructose; growth in closed arm Acid from glycerol No growth in closed arm with lactose, maltose, dextrin, glycerol or mannitol. No acid from lactore

Starch not hydrolyzed.

Hydrogen sulfide production feeble. Growth in broth with 1.0 per cent NaCl retarded; inhibited with 2.0 per cent.

Very sensitive to acid (phenolphthalein): Temperature relations: Optimum 25°

to 30°C. Minimum about 8°C. Maximum 34° to 35°C. Thermal death point 43°C for one hour.

Aerobe and facultative anaerobe. Source: From various curcurbits.

Habitat: Causes the wilt of cucumber, also affects cantaloupes, muskmelons, numpkins and squashes.

6a. Bacillus tracheiphilus var. cucumis E. F. Smith. (An Introduction to Bact. Dis. of Plants, 1920, 135.) Smith states that squash is immune to this variety of Erwinia tracheiphila.

7 Erwinia betivora (Takimoto) Magrou. (Bacillus betivorus Takimoto, Ann. Phyt. Soc. Japan, 2, 1931, 356; Magrou, in Haudurov et al., Dict. d. Bact. Path., Paris, 1937, 200). From Latin, devouring the beet.

Rod: Short rods, sometimes filaments. Motile with 2 to 6 peritrichous flagella.

Gram-negative.

Gelatin: Liquefaction.

Agar colonies. Circular or amoeboid. homogenous, thin, edges smooth and entire

Broth . Turbid with pellicle.

Milk Acid: coagulated.

Nitrites produced from nitrates

Indole produced.

Hydrogen sulfide produced. Cas from glucose and sucrose.

Facultative anaerobic.

Optimum temperature 35°C, Minimum 12°C. Maximum 45°C. Thermal death point 50°C for 10 min

Source: From rot of sugar beets in Korea.

Habitat: Pathogenic on roots of beets. Artificial inoculation of carrots, radishes, potato tubers and tomato fruits gave positive results.

8. Erwinia carnegicana Lightle, Standring and Brown, (Phytopath., \$2, 1942. 310.) From the genus Carnegica.

Rods: 1.12 to 1.79 by 1.56 to 2.90 microns. Motile with peritrichous flagella. Capsules. Cram-positive (Lightle et al.). Gram-negative: old cultures show Gram-positive granules in cells (Burkholder).

Gelatin: Slow liquefaction.

Agar colonies: Round, slightly raised, smooth, gray-white, wet-shining, marcins entire.

Broth: Abundant growth.

Uschinsky's solution: Turbid, slight ring and sediment.

Milk: Litmus pink to reduced. No curdling.

Nitrites are produced from aitrates. Hydrogen sulfide is formed (Burkholder).

Acid and gas from glucose, galactose, fructose, maltose, sucrose, raffinose, mannitol and salicin. Acid and gas from lactose and xylose and alkali from sodium tartrate (Burkholder).

Starch not hydrolyzed (Burkholder).

No odor.

Aembic. Thermal death point 59°C.

Source: From rotting tissue of the giant cactus (Carnegiea gigantia).

Habitat: Pathogenic on the giant cartus, but not on carrots

9. Erwinia atroseptica (van Hall) (Bacillus atrosepticus ran Jennison. Hall, Inaug. Diss., Amsterdam, 1902, 134; Jennison, Ann Missouri Bot. Gard, 10, 1923, 43.) From Latin aler, black

and septicus, putrelying. Synonyms: Morse (Jour. Agr. Res , 8, 1917, 79) lists the following synonyms: Bacillus solanisaprus Harrison, Cent. f. Bakt., 11 Abt , 17, 1906, 3t (Erwinsa solanisapra Holland, Jour. Bact., 5, 1920, 222) and Bacillus melanogenes Pethybridge and Murphy, Roy. Irish Acad.

Proc., 29, B, No. 1, 1911, 31. Paine (Jour. Agr. Sci., 8, pt. 4, 1917, 492) agrees and points out that Bacillus phytophthorus Appel is very similar to Bacillus mclanogenes Pethybridge and

Murphy.

Jennison (Ann Missourt Bot. Gard., 10, 1923, 1) concurs and adds Bacillus phytophthorus Appel, Ber. d. Deut Bot. Gesell., 20, 1902, 128 (nomen nadum) and K. Biol. Anst. f. Land. v. Forst Arb., 5, 1903, 381 (This hast reference contains Appel's description which is antedated by van Hall's description of the black log pathogen.

Stapp (Arb. d Biol. Reighs f Landu Forst., 16, 1923, 702) besides the above species adds Bacillus carolvorus Jones but uses the name Bacillus phytophthorus and states that the species contains 5

serological groups.

Description from Jennison (loc. cst.). Rods: 0 6 by 1 5 microns. Motile with a few portriebous flagells. No capsules Gram-negative.

Gelatin liquefied

Agir colonies: Small, round to somewhat irregular and whitish. Surface smooth with a glistening luster.

Broth: Turbid after a few days Ring and sometimes a light pellicle

Ammonia production feeble to moderate (Jennison). Ammonia production absent (Morse, loc cit).

Milk congulated and acid. A slow pentonization. Litmus reduced

Indole not formed.

Hydrogen sulfide not produced Nitrites are produced from nitrates

Acid and gra from glucose, galactose, sucrose, lactose, maltose and mannitol No acid and gas from dettrin and glycerol. Volume of gas is small.

Starch not hydrolyzed.

Cohn's solution: No growth.
Uschinsky's solution: Good growth.
Facultative angrobe (Morse, loc cit)
Optimum temperature 20°G. Maximum 33°C. Minimum below 5°G
(Morse).

Slight growth with 3 per cent salt. None with 4 per cent salt. Source: From stems of potatoes affected with black-leg.

Habitat: Causes a black rot on stem and tuber of potatoes and other vegetables.

Nore: Smith (Science, \$1, 1910, 748) regarded Erwinia solanisapra and Eruinia phytophthora as very closely related. Brooks, Nain and Rhodes (Jour. Path. and Baet., £8, 1925, 203) held that Erwinia phytophthora, Erwinia solanisapra and Erminia carolovora are distinet serologically, although identical in cultural characteristics. (Ann. Appl. Biol., 13, 1926, 12) claimed from semiorical tests that Erunnia phytophthora and Erwinia solanisapra are different yet closely related organisms. Lacey (Ann. Appl. Biol., 13, 1926, 1) from cultural and serological tests considered Erwinia phytophthora, Erminia solanisapra and Erminia carotorore distinct species. Stapp (Arb. a. d. Biol. Reichanstalt f. Landw. u. Forstwirtsch., 16, 1928, 643) from serological tests places Erumna phytophthora in one serological group and Erwinia carologora in another, Leach (Phytopath., 20, 1930, 743) found that Erreinia phytophthora and Erwinia carologora nere indistinguishable in cultural and physiclocical characteristics, the most coneistent difference being the inky black coloration of the tissues infected with the former.

Stapp (in Somwer, Handb & Pflanreak., 5 Auf., 2, 1923, 222) states that it is generally believed that the disease caused by Bacillus solanincola Delacroit (Compt. rend. Acad. Sci., Paris, 153, 1901, 417 and 1000) is the same as stem not of potato (blackleg).

10. Erwinia carotovora (Jones) Holland. (Bacillus carolororus Jones, Cent. f. Bakt., II Abt., 7, 1901, 12; Holland, Jour. Bact., 5, 1920, 222; Racterium carotororum Lehmann and Neumann, Bakt. Diag., 7 Auli., 2, 1927, 446; Pectobaclerium carotovorum Waldee, Iowa State Coll. Jour. Sci., 19, 1945, 469.) From Latin, carrot destroying.

Synonyms · Leach (Minnesota Agr. Exp. Sta. Tech Bull. 76, 1931, 18) lists the following as synonyms:

Bacillus atroseptieus van Hall. (Van Hall, Inaug. Diss, Univ Amsterdam, 1902, 134; Erwinia atroscotica Jennison. Ann. Missouri Bot. Gard., 10, 1923, 43.)

Bacillus phytophthorus Appel. (Ber. d. deut Bot, Ges., 20, 1902, 128; Erwinia phytophthora Holland, Jour. Bact., 5, 1920, 222; Bacterium phytophthorum Burgwitz, Phytopath. Bacteria, Lemngrad, 1935, 141; Pectobacterium phytophthorum Waldee, Iowa State Call Jaur. Sci., 19, 1945, 471)

Bacillus solanisaprus Harrison. (Harrison, Cent f. Bakt , H Abt , 17, 1907, 34; Erwinia solanisapra Holland, Jaur. Bact., 5, 1920, 222.)

Bacillus melanogenes Pethybridge and Murphy. (Roy Irish Acad , 29, B, Na. 1, 1911, 31)

Bacıllus oleraccae Harrison (Harrison, Science, 16, 1902, 152, Erwinia oleraceae Holland, Jour Bact , 5, 1920, 222.)

Bacillus omnivorus van Hall. Diss., Univ. Amsterdam, 1902, 176)

Bacillus apnorus Wormald Sci., 6, 1914, 203.)

Elrod (Bot Gaz, 105, 1941, 270) holds that Erwinia aroideae is a synanym of Erwinia carotovora

The following also have been considered drwinia atroseptica (van Hall) as possible synonyms of Erwinia cara-ison. tovora:

Bacillus cepivorus Delaeroix. croix, Ann. Inst Nat Agron, Ser 0, 1923, 43.) From Latin ater, black 5, 1905, 368, Bacterium cepivorum Stapd septicus, putrefying. in Sorauer, Handb. d. Pffanzenkranfynonyms: Morse (Jour. Agr. Res , & heiten, 5 Aufl., 2, 1928, 49; Aplanobacte. 79) hats the following synonyms: cepivorus Elliott, Man Baet Plant Path ,lus solanssaprus Harrison, Cept. f. ceptiorus Elliott, Mali Biec I I Marcou. II Abt., 17, 1906, 31 (Erwind 1930, 4; Phytomonas ceptiora Magrou. II Abt., 17, 1906, 31 (Erwind in Houdirov et al. Dict. d. Bact. Path., sapra Holland, Jour. Bact., 6, 1920, in Hauduroy et al , Dict d. Bact. Path , sapra Holland, Jour. Bact., 6, 1920, 1937, 344.) Causes a rot of onion bulbs. and Bacillus melanogenes Pethy.

Cent f. Bakt., II Abt., 51, 1911, 85; 29, B, No. 1, 1911, 31. Erwinia cypripedii Bergey et al., Manual, \ (Jaur. Agr. Sci., 8, pt. 4, 1917, 1st ed., 1923, 171.)

Bacillus dahliae Hcr. and Bokun (Hori and Bokura, Imp. Agr. Expt. Sta. Nishigahara, \$8, 1911, 69; Erwinia dahlaa Magrou, in Hauduroy et al., Dict. d Baet. Path., 1937, 205.)

Pseudomonas destructans Potter (Patter, Proc. Univ. Durham Philos. Soc., 1899, 165 and Proc. Roy. Soc., 67, 1900, 449; Bacterium destructans Nakata, Nakajima and Takimoto, Tech. Rept Karea Ind. Farm, 1922; Phytomonas destructans Bergey et al., Manual, 3rd ed., 1930, 264.) Sec Paine (Ann. Appl. Biol., 5, 1918, 64) for a discussion of this species.

Bacillus hyacinthi septicus Heinz. (Heinz, Cent. f: Bakt., 5, 1889, 539; Bacillus hyacinthi-septicus Lehmann and Neumann, Bakt. Diag., 2 Aufl., 2, 1899, 449; Bacterium hyacinthi septicus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 127; Bacillus hyacinthi Migula, Syst. d. Bakt., 2, 1900, 874; not Bacillus hyacinthi Trevisan, I generi e le specie delle Batteriacee, 1899, 19, Eruinia hyacinthi septica Magrou, in Hauduroy et al , Dict. d. Bact. Path, 1937, 208)

Rads. Usually 0.7 to na microns, a point 59°C. rather 3th rotting tissue of the giant nitharnegiea gigantia). suls: Pathogenic on the giant cace nat on carrots

(Bacillus atrosepticus van d, Inaug. Diss., Amsterdam, 1902,

(De di; Jennison, Ann. Missouri Bot. Gard,

Bacillus cypripedia Hora. (Hori, and Murphy, Roy. Irish Acad

Potato: Growth thick, creamy-white; medium softened. Dunham's solution Feeble persistent

turbidity. Blood serum: Growth much as on agar.

Not liquefied. Uschinsky's solution Strong turbidity.

Indole production none.

Nitrites produced from nitrates Diastase negative.

No II:S produced or only a trace No ammonia produced

Methyl red positive, Voges-Proskauer negative (Dowson, Cent f Bakt, II Abt., 100, 1939, 183).

Acid and gas from glucose, lactose, sucrose, fructose, raffinose, mannitol, arabinose, vylose, salicin and rhamnose Acid without gas from glycerol and ethyl alcohol Butyl alcohol, inulin and starch not fermented.

Facultative anerobe

Temperature relations · Optimum 25° to 30°C. Minimum 4°C Maximum 38° to 39°C Thermal death point 41° to 51°C

Pathogenesis · Causes a rapid soft rot of roots, rhizomes, fruits and the fleshy stems of a variety of plants

Source. From rotted carrots. Habitat: Causes a soft rot in carrot. cabbage, celery, eucumber, egg-plant, iris, muskmelon, hyacinth, onion, parsnip, pepper, potato, radish, tomato, turnip, and other plants.

11. Erwinia erivanensis (Kalantarian) Bergey et al. (Bacterium grivanense Kalantarian, Cent f. Bakt, H Abt, 65, 1925, 298, Bacillus eritanensis Stapp, m Sorauer, Handb d. Pflangentr , 5 \ufl, 2, 1928, 202; Bergey et al , Manual. 3rd ed., 1930, 239) Derived from Erman, a city in Armeum Whether this organism is to be con-

adered a chronogeme atram or a distinct "mecies is impossible to determine, there-(tie. it occupies its present position

Slight ely. It cannot be separated None with min carologora on the basis of chromogenesis since the latter occasionally shows a tendency to the formation of a faint vellowish pigment

Rods: 05 to 07 by 1.25 to 25 microns. Motile with peritrichous flagella. Gram-

negative.

Gelatin colonies Alter 3 days at 20°G, circular, 1 to 1 5 mm in diameter, yellowish-white, convey, entire Microscopically gray with opaque borders and darker natches

Gelatin atab Surface growth somewhat umbonate In 10 to 12 days a slow lique. faction. Intense vellow growth.

Agar colonies Grayish-white, fatty lustre, turning yellow after several days Agas slant. Growth grayish-white, fatty lustre, becoming yellow

Broth. Strong more or less flocculent turbidity No surface growth, Little sediment.

Potato. Growth somewhat raised, be-

coming yellowish Milk Congulated in 14 days, becoming alkaline, slowly clearing.

Indole is formed.

Nitrites not produced from nitrates Acid and gas from glucose, sucrose and mannitol. No gas from lactose and glycerol

Optimum temperature 20°G.

Source From cotton plants. Habitat. Causes a root-rot of cotton (Cossupium ap )

12 Erwinia flavida (Pancett) Magrou (Bacillus flaridus Fancett, Rev Indust. y Agrico de Tucuman, 13, 1922, 5; llev. App Mycology, 2, 1923, 338, not Bacillus flaridus Morse, Jour. Inf Dis , 11, 1912, 281. Magrou, in Hauduroy et al , Dict. d Bact Path., 1937, 207 ) From Lativ flatur, yellon

Morphology Mattle with pertirehous flagella Gram-negative. Gelatin, Yellow growth, Liquefac-

tton. Milk. Coagulated

Potato Yellow growth

Indule is formed.

Nitrites not produced from nitrates. Acid and gas from glucose, lactose and sucrose.

Diastase not formed.

Source: From sugar cane.

Habitat: Causes a soft rot of sugar cane (Saccharum officinarum).

Nore: If this decay is due to a simple organism as stated above, it is probable that it should be considered merely a chromogenic strain of Erwinia carotevora.

13. Erwinia dissolvens (Rosen) comb. (Pseudomonas dissolvens Rosen, Phytopath., 12, 1922, 497; Phytomonas dissolvens Rosen, Phytopath., 16, 1926, 264; Bacterium dissolvens Rosen, ibid.; Aplanobacter dissolvens Rosen, ibid.; Aerobacter dissolvens Waldee, Iowa State Coll. Jour. Sci., 19, 1945, 473.) From Latin, dissolving.

Rods: 0.5 to 0.9 by 0.7 to 1.2 microns. Pairs, rarely in chains. Capsules present. First described as motile with a single flagellum, later as non-motile. Gram-negative.

Golatin. Not liquefied.

Agar colonies: Round, margins entire, white, opaque, glistening, butyrous, emitting a strong odor of decaying vegetables.

Broth Turbid with heavy surface growth consisting of ring, and floccules or compact slimy masses and streamers. Abundant sediment.

Uschinsky's solution: Good growth, but not viscid.

Litmus milk: Acid, coagulated-

Indole produced.

Nitutes produced from nitrates. Hydriogen sulfide not produced-Acid hand gas from glucose, galactose,

mannitodi, sucrose, maltose, lactose and giycerol Ph.

Starch by dydrolyzed.

Optimur Ca temperature 30°C.

Good growypyth in 3 per cent salt. Retarded at 4 kt., her cent.

Source: Fripedim rotting corn stalks. Rabitat. P. 171.)thogenic in corn plants.

14. Erwinia nimipressuralis Carter. (Illinois Nat. Hist. Survey Bull, 23. 1945, 423.) From Latin nimis, too much and pressuralis, pertaining to Dressure.

Rods: Mostly 0.34 to 0.68 by 0.68 to 1.35 microns. Motile with as many as 6 peritrichous flagella. Capsules not observed. Gram-negative.

Gelatin: Not liquefied.

Potato glucose agar: Colonies circular, amouth, whitish-cream, entire, flat to alightly raised and usually opaque. Gas produced when medium is stabled.

Broth: Abundant with this pellicle or flocculent surface growth. Sediment scant and viscid. Gas produced in nutrient broth plus glucose was 47 per cent CO: and 2.4 per cent hydrogen CO; varied with age of culture, more being produced in young cultures.

Milk: Acid, congulated. Litmus and bromocresol purple are reduced. Not peptonized.

Nitrates produced from nitrates.

Hydrogen sulfide produced.

Indole not produced. Acid and gas produced from arabinose, rhamnose, xylose, glucose, fructose, galactose, mannose, lactose, maltos, trehalose, melibiose, cellobiose, mannitol, sorbitol and solicin; no acid or gas from inulin, dextrin or filterpaper; variable results from sucrose, raffinese, melesitose, dulcitol, glycerol and elm sawdust. Pectin is not fermented.

Starch not hydrolyzed.

Methyl red test positive. Acetylmethylcarbinol produced.

Facultative anacrobe.

Optimum temperature 21° to 30°C Maximum 37°C. Minimum 5°C or lower

Thermal death point 45° to 55°C. Optimum pH for growth 68 to 75

Maximum 100+. Minimum 46. Source: Five cultures from 5 different

trees affected with net wood.

Habitat: Pathogenic in trunk wood of elms, Ulmus americana, U. pumila, U fulva and U. procera.

15. Erwinia ananas Serrano (Philippine Jour. Sci., 39, 1928, 271; Bacillus ananas Serrano, ibid.; Bacterium ananas Burguitz, Phytopathogenic Bactera, Lenugrad, 1935, 44.) Named for the genus. Ananas.

Note: Not to be confused with Pseudomonas (Phytomonas) ananas Serrano, Philippine Jour. Sci., 36, 1928, 271.

Short rods: 06 by 09 micron, with rounded ends, occurring singly, in pairs and in short chains. Encapsulated. Motile with peritrichous flagella. Gramnegative.

Gelatin stab. Stratiform liquefaction, with a deep chrome-yellow sediment.

Potato glucoso agar: Atter 21 hours, circular, 3 mm in diameter, convex. denso, homogeneous, entire, most, stravyellow, mottled, becoming primuline yellow. Plates have a molasses odor. Show two types of colonies, rough and smooth Rough colonies have create margins.

Potato glucose agar slant. Growth straw-yellow, raised, becoroing primuline yellow, moist, glistening

Broth: Turbid, with a straw-colored pollicle and ring

Glucose broth: Growth sulfur yellow. Litmus milk: Coagulated, faintly

acid, becoming alkaline.

Potato. Copious growth, moist, glistening, spreading, becoming primuline yellow.

Indole not formed.

Blood serum: Moderate growth, slightly raised, mustard yellow to primuline yellow. No liquefaction after 3 months

Cohn's solution · No growth. Phenol negative.

Diastase produced.

Nitrites produced from nitrates.

Slight amount of ammonia produced.

Small amount of alcohol and aldehyde produced.

No gas from carbohydrates. Acid from glucose, lactose, sucrose, mannitel, raffinose, glycerol, salicin, devtrin, maltose, fructose and mannose. No acid from arabinose, xylose, amygdalın, rhamnose, inositol, inulin, dulcitol, adonitol, asparacine or starch.

Source: From the pinespple (Ananas sativus) and sugar-cane (Saccharum officinarum).

Habitst: Causes a brown rot of the fruitlets of pineapple.

16 Erwinia cytolytica Chester. (Phytopath., 28, 1938, 431.) From Latin, cell

dissolving.

Rods · 0 6 to 0 7 by 2 5 to 3 5 microns.

Singly or in pairs Gram-negative. Mo-

tile with peritrichous flagella.
Gelatin: Slow liquefaction

Agar colonies: 2 to 3 mm in diamoter, round, convex, moist, glistening, grayishwhite, watery, translucent. Light brownish-vellow by transmitted light.

Broth: Turbid.

Milk. Coagulated in 5 to 7 days.

Slightly seed. Not digested Nitrates produced from nitrates.

Indole not formed.

Hydrogen sulfide not formed.

Acetylmethylcarbinol. A slight reaction.

Acid without gas from glucose, luctore, sucrose, raffinose, mannitol, salicin and isodulettel. No acid from fructose, arabinose, xylose, glycerol and inulin.

Starch hydrolyzed.

Pectin dissolved.

Asparagine, peptone, and ammonia used as nitrogen sources in synthetic medium plus glucoee. Potassium nitrate not used

Optimum temperature 28° to 30°C. Growth at 37°C Slow growth at 20°C and no growth at 8° to 10°C.

Good growth at plI 68 to 7.3. Feeble growth at 50 No growth at 4.4.

Aerobic and facultative anaerobic. Source: Several isolates from diseased

dahlers in New York Botanical Carden.

Habitat: Causes a rot of the tuber and stems of dablins

17. Erwinia aroldeae (Townsend) Halland. (Bacillus oroideae Townsend, U. S. Dept. Agr., Bur. Plant Ind. Bull. 60, 1904. 40; Holland, Jour. Bact., 5, 1920, 222; Bacterium aroideae Stapp, in Sorauer, Handb. d. Pflanzenkr., 5 Aufl., 2, 1928, 41; Pectobacterium aroideae Waldee, Iowa State Coll. Jour. Sci., 19. 1945, 172.) From Greek, pertaining to the family Aracege.

Probable synonyms: Erwinia craci (Mizusawa) Magrou, (Bacillus eroci Mizusawa, Kanag. Agr. Exp Sta Bull. 51, 1921, 1; Ann Phytopath. Soc. Japan, 1, 1923, 1; Magrou, in Hauduroy et al., Dict. d Bact. Path., 1937, 204.) Attacks Crocus sativus, also anion.

Erwinia melonis (Giddings) Holland. (Bocillus melonis Giddings, Vermant Agr. Exp Sta Bull, 148, 1910, 413; Holland, Jaur. Bact., 5, 1920, 222; Pectobacterium melonis Waldee, Iowa State Coll. Jour. Sci., 19, 1945, 473.) E. F. Smith (An Introduction to Bact. Dis of Plants, 1920, 249) considered Eruinia melonis and Erwinia oroideae identical. Causes a soft rot of muskmelon

Erwinia papaveris (Ayyar) Magrou. (Bacillus papareris Ayyar, Mem. Dept. Agr. India, Bact. Ser 2, 1927, 29, Magrou, in Hauduroy et al , Dict d Baet Path . 1937, 214 ) The cause of a soft rot of the

garden poppy. Rods: 0.5 by 2 to 3 microns, with rounded ends, occurring singly, in pairs and in fours, also in chains under certain conditions Motile with peritrichous flagella. No capsules. Gram-negative. Gelatin stab · Narrow infundibulifarm

liquefaction.

Agar colonies Circular to amoeboid. white, glistening Borders sharp Granular structure

Agar slant Growth white to grayishwhite, moist, glistening. Medium not discolored

Broth · Turbid.

Potato: Growth whitish, with tinge of vellow. Medium graved

Litmus milk: Coagulated, acid, with

separation of whey, not peptonized. Litmus reduced.

Indole not formed.

Nitrites produced from nitrates.

Acetylmethylcarbinol Methyl red negative (Donson, Cent. f. Bakt., II Abt., 100, 1939, 183).

Acid without gas from glucose, lactose. aucrose, maltose, mannitol, glycerol, fructose, raffinose, arabinose and xylose Growth in closed arm.

Diastase slight.

Hydrogen sulfide produced.

Uschinsky's solution: Good growth No growth in nitrogen. Growth feeble in II: and CO:.

Temperature relations: Optimum 35°C. Minimum 6°C. Maximum 41°C. Thermal death point 50°C for 10 minutes.

Facultative anserobe.

Differential characters: See Eruinia caratovara. Massey (Phytopath., 14, 1924, 460) considered Erwinia aroideat and Erwinia corotorora distinct species, though closely related. Link and Taliaferro (Bot. Gazette, 85, 1928, 198) found them distinct serologically. (Ann. Appl. Biol., 28, 1941, 102) differentiated them on their action on maltose and xylose.

Source: From rotted calls hily.

Habitat: Causes a soft rot of calla. Affecta raw potato, egg-plant, cauliflawer, radish, cucumber, cabbage, parsnip, turnip, salsify, tomato (ripe and green).

18 Erwinia mangiferae (Doidge) Bergey et al. (Bacillus mangiferae Doidge, Ann Appl. Biol., 2, 1915, 1; Bergey et al , Manual, 1st ed., 1923, 173.) Named for the genus, Mangifera.

Rods: 06 by 1.5 microns, occurring singly and in chains, with rounded ends Encapsulated. Motile with peritrichous Gram-negative.

flagella Gelatin stab: Medium liquefied in 10

to 17 days. Growth yellow.

Agar colonies: Glistening, yellowish, undulate borders.

Agar slant: Growth yellow, glistening. Broth: Turbid, with yellow ring.

Litmus milk: Slow coagulation at 37°C. Slight acidity. Casein slowly dissolved. Litmus reduced.

Potato: Growth spreading, glistening, yellowisb. Medium not discolored.

Indele formed in pertone solution

Indole formed in peptone solution Phenol negative,

Nitrites produced from nitrates

No H<sub>2</sub>S produced. No ammonia in broth.

Feeble acid production without gas from glucose, lactose, sucrose, fructose and glycerol. No growth in closed arm with lactose and glycerol, more or less growth in closed arm with glucose, sucrose, fructose, maltose, raffinose and manuful.

Diastase not formed.

Produces an enzyme capable of dissolving the middle lamella but without action on cellulose.

Cohn's solution: Slight turbidity.

Uschinsky's solution: No growth Fermis' solution with starch jelly No growth

Pigment insoluble in water, alcohol, ether, chloroform or dilute acids Temperature relations Optimum 30°C

Minimum 5° to 6°C. Maximum 45°C Thermal death point 60°C.

Source: From the mango in Africa Habitat Causes a disease of the mango (Mangifera indica).

19 Erwlala cittimaculans (Dodge) Magrou (Baculus cirrmaculans Dodge, Ann. Appl. Bool., 5, 1917, 53; Bocterum cirrmaculans Burgaits, Phytopath Bacteria, Leningrad, 1935, 191; Magrou, an Hauduroy et al., Diet. d. Ract Fath, 1937, 203.) From the genus Citrus and Latin maculans, spotting.

Rods: 0.48 to 0.7 by 0.8 to 3.2 macross Mottle with peritrichous flagells Conspicuous capsule present Gram-positive. Dowson thinks this species Gramnegative (Cent. f. Bikt., 11 Abt., 100, 1937, 181). Gelatin: Liquefied.

Agar colonies: Subcircular, yellow, with dense grumose centers Broth: Turbid, with pellicle and sedi-

Broth: Turbid, with pellicle and sediment.

Milk: Coagulated, with precipitation

of casein and extrusion of whey. Not peptomized Litmus gradually reduced. Blood serum: Not liquefied.

Indole is formed.

Nitrates produced from nitrates with evolution of gas,

Ammonia produced in broth.

Acid without visible gas from glucose, sucrose, fructose, galactose, maltose and mannitol. No acid from lactose, glycerol, dextrin or starch.

Diastase not produced.

Cohn's selution No growth.

Usehinsky's solution: Growth present. No growth in broth over chloroform. Methylene blue and neutral red reduced.

Pigment insoluble in water, alcohol, ether, chloroform, carbon bisulfide, dilute acid or alkalis

A turbid growth is produced in 10 per cent salt

Temperature relations: Optimum 35°C.

Maximum 43°C. Thermal death point 62°C for 10 minutes.

Facultative anaerobe.

Source From diseased lemons and oranges

Habitat Causes a spot disease of citrus. In nature attacks lemons, oranges, navrijes and has also been successfully moculated into limes, shaddock, grapefruit and citron. Seville oranges are resistant.

20 Erwinta rhapontici (Millard) combnor (Phylamona: rhapontica Millard, Umw Leeds and York-thire Council for Agr. Ed. Bul. 131, 1924, 111; Bacterium rhaponticum Millard, 1964; Inflanobacter rhaponticum Elliott, Nian Bact. Plant Path. 1930, 12) From Greek. Rha pontic, rhubarb of Pontius, a province of Asis Minors, M. I. Rheum rhaponticum Description from Metcalfo, Ann. of Appl. Biol., 27, 1940, 502, where he suggests it belongs in Erwinia.

Rods: 0.5 to 0.8 by 1.2 to 1.5 microns. Motile with 3 to 7 peritrichous flagella. Gram-negative.

Gelatin stab: Beaded growth. No liquefaction.

Infusion agar: Colonies circular, convex, smooth, glistening, translucent, with margins entire, 2 to 3 mm in diameter in 48 hours at 25°C.

Rhubarb agar: Colonies slightly larger, often with a yellowish tinge.

Tryptophane broth: Turbid with fragile pellicle, a slight rim and slight flocculent deposit.

Milk: Acid in 3 to 4 days with or without slight curd separation. No clotting.

Indole not produced. Nitrites formed from uitrates.

Acetylmethylcarbinol produced. No hydrogen sulfide produced.

Cohn's solution: Moderate growth.

Acid but no gas from arabinose, xylose, glucose, galactose, fructose, mannose, lactose, maltose, sucrose, mannitol, glycarol and salicin.

Growth in citrate solution Starch not hydrolyzed.

Chromogenesis: Water-solubio pinkish pigment in various media.

Growth from 0°C to 37°C and possibly higher.

Distinctive characters: Differs from Erwinia aroideae in that it does not liquify gelatin nor clot milk and is chromogonic. It also has a limited host range.

mogetic. It also has a limited host range. Source: From rotting rhubarb crowns. Metcalfe used 6 isolates from various sources in describing the pathogen.

Habitat: Causes a crown-rot of rhubarb.

21. Erwinta lathyri (Manns and Taubenhaus) Holland. (Bacillus lathyri Manns and Taubenhaus, Gardener's Chronicle, 63, 1913, 215; Manns, Delaware Agr Exp. Sta., Bul. 108, 1915, 23; Holland, Jour Bact., 6, 1920 218; Bac-

terium lathyri Burgwitz, Phytopath. Bacteria, Leningrad, 1935, 76.) From the genus Lathyrus.

Rods: After 24 hours at 25° to 25°0, 0.6 to 0.85 by 0.75 to 1.5 microns, with rounded ends. No capsules. Motile with peritrichous flagells. Gram-negative.

Gelatin colonies: After 8 days, circular, slightly convex, edges smooth Liquefaction too slow to show on plate,

Gelatin stab: Growth best at surface Line of stab filiform. Liquefaction slow, fairly well begun in four weeks, complete in three months.

Agar colonies: After 24 hours, yellow, stellate to amoeboid, smooth, glistening, slightly raised, entire. Centers grauular, yellow.

Ager slant: Growth filliorm, slightly convex, smooth, glistening, opaque, butyrous, light to deep yellow. Odor absent.

Broth: Strong turbidity in 21 hours, little or no pellicle. Sediment scant. Litmus milk: Slow increase of soldity,

not always sufficient to cause coagulation. Digestion of casein slow and variable. Potato: Growth rapid, filiform, sighticonvex, amooth, glistening, butyrous t slightly viscid. Light to deep yellow

Medium not discolored. Indole is formed.

Cohn's solution: No growth.

Uschinsky's solution: Rapid growth sometimes a pellicle. Fluid viscid.

Asparagine solution: Good growth. Nitrites are not produced from ni

Ammonia produced in broth and as

paragine solution.

No gas from carbohydrates. Acid
from glucose, lactose, sucrose, mannitel
from glucose, lactose, sucrose, mannitel

and glycerol. No growth in closed am Diastase not formed or extremely

Growth in broth over chloroform

Growth inhibited by 4 per cent NaCl Temperature relations: Optimum 23° to 30°C. Thermal death point 46° to 48°C for 10 minutes.

Acrobic.

Source: From sweet peas.

Habitat: Stated to be pathogenic for sweet pea (Lathyrus odaratus) and other legumes. Considered by many to be a saprophyte.

22. Erwinia IIII (Uyeda) Magrou. (Bacillus IIII Uyeda, by Bokura, Ann Phytopath. Soc. Japan, 1(2), 1919, 36, Magrou, in Hauduroy et al., Duct d. Bact. Path., 1937, 210). From Latur lilium, a name taken from the Greek hut derived from the Celtic word it meaning white. M. I., generic name, Lilium

Translated by Marion Okumoto. Rods: 0 6 to 0.7 by 0.8 to 10 micron. No capsules. Motile with 6 to 8 pertrichous flagella. Gram-positive(?)

Gelatin · Liquefaction.

Gelatin plate Colonies after 2 days, round and smooth with grayish surface Broth: Alkaline, ammonia produced.

Milk. Curd formation.

Indole produced.

Nitrites produced from nitrates. Hydrogen sulfide produced.

Sugar medium changes to a brown color Conne not utilized.

Acrobic, facultative.

Optimum temperature 32° to 34°C. Killed in 3 min at 50°C. Resists—20°C for 30 min,

Source: From brown spots on hily bulbs in Japan.

Habitat: Causes a disease of hily bulbs and leaves.

Appendix: The following additional species are found in the literature. Many are incompletely described.

Bacillus brassicaciorus Delacroix (Compt rend Acad. Sci. Paris, 140, 1905, 1356.) Presumably causes a rot of cabbree.

Bacillus farnetianus Pavarino. (Atti R. Accad. Naz. Lincci Rend Cl. Sci. Fis., Mat. e Nat., 20, 1911, 233.)

Bacillus putrefaciens putridus Dela-

eroix. (Ann. Inst. Nat. Agron., 5, 1906, 154.) Pathogenic for tobacco.

Bacillus solaniperda Migula. (Syst. d. Bakt., 2, 1900, 573; Bacillus krameri Chester, Man. Determ. Bact., 1901, 2001, Chester, the control of the control of

282 ) Causes a soft rot of potato.

Bacillus spiechermanni Jaczewski.

(Efficit, Bacterial Plant Discases, 1935, 67.) Name applied to a species described by Spieckermana (Landw. Jahrb., 31, 1902, 195) but left unnamed

Bacillus tabacivarus Delacroix. (Ann. Inst. Nat Agron., 5, 1906, 266.) Said to cause collar rot of tobacco

Bacillus tabificans Delacroix. (Compt. rend. Acad. Sci., Paris, 157, 1903, 871.)
Said to cause spotting of tobacco leaves.

Bacterium Iochnisi Kalantarian, (Kalantarian, Cent. f. Bakt., II Abt., 85, 1925, 301; Phylomonas Iochnisi Bergey et al, Manusl, 3rd ed., 1930, 276.) From diseased cotton plants Perlirichous.

Bacterium lycopersici Burgaitz. (Zischr f. Pflanzenkr., 34, 1924, 301.) From a blossom end rot of tomato

Erionia ollieriae (Omori) Magrou. Bacillus alhariae Omori, Official Gaz. ol Japan, 11, 1800, No. 3755; Magrou, in Hauduroy et al., Diet. d. Bact. Path., 1937, 195) Causes a root rot of horseradish.

Erusia araliatora (Uyeda) Magrou. (Bacallus araliatorus Uyeda, Bull. Imp. Agr. Exp. Sta. Tokyo, 55, 1909, 61; Magrou, in Hauduroy et al., Diet. d. Bact. Path., 1937, 197.) Caures a root of grassens.

Erusna asteracarum (Pavarino) Magrou. (Bacilles asteracarum Faravino, Atti R. Accad. Nar. Lincei Rend. Cl. Sci Fis., Mat. e Nat , Ser. 5, 21, 1912, 544, Magyon, in Hauduroy et al., Dict. d Bact. Path., 1937, 199) Pathogenic for the aster (Aster chinensis).

Ertenne bussei (Migula) Magrou. (Baculus B. Busse, Zischt. I. Plannenkt. 7, 1897, 74; Breillus bussei Migula, Syst. d. Bakt. 2, 1909, 779; Becillus betae Lehmann and Neumann, Bakt. Diag., 4 Anfl., 2, 1907, 599; not Beacilus betae Migula, Syst. d. Bakt. 2, 1909, 779; Magrou, in Hauduroy et al., Dict. d. Bact. Path., 1937, 200.) Pathogenic for the sugar beet.

Erwinia cacticida (Johnston and Hitchcock) Magrou. (B. cacticidus Johnston and Hitchcock, Trans. and Proc. Roy. Soc. South Australia, 47, 1923, 162; Magrou, in Hauduroy et al., Diet. d. Bact. Patl., 1937, 201.) Causes a rot of cactus.

Erwinia edgeworthiae (Hori and Bokura) Magrou. (Bacillus edgeworthiae Hori and Bokura, Ideta Arata, Supplement to Handbook of the Plant Diseases of Japan, 1, 1925, 32; Magrou, in Hauduroy et al., Diet. d. Baet. Path., 1937, 206.) Pathogenic on Edgeworthia chrysontha, an oriental shrub.

Eruinia izue (Severim) Magrou. (Bacillus zziae Severini, Annali di Botaniea, Rome, II, 1913, 413; Magrou, in Hauduroy et al., Dict. d. Bact. Path., 1937, 208.) Pathogenic on gladiolus and other bulbs.

Erwinia nelliae (Welles) Magrou. (Bacillus nelliae Welles, Philippine Jour. Sci., 20, 1922, 279; Magrou, in Hauduroy et al., Dict. d. Bact. Path., 1937, 213.)

Erwinta papayae (Rant) Magrou. (Bacillus papayae Rant, Cent. f. Bakt., II Abt., &4, 1931, 483; Magrou, in Hauduroy et al., Diet d. Bact Path , 1937, 214.) Pathogenic on papaya.

Erwinia sacchari Roldan. (Philippine Agric., 20, 1931, 256; Bacillus saccharum Roldan, idem; not Bacillus sacchari Janse, Mededeel. uit's Lands. Plantentuin, 9, 1891, 1.)

Erwinia scabiegena (von Faber) Ma grou. (Bacterium scabiegenum von Faber, Arb. Kais. Biol. Anst. f. Land u Forstw., 5, 1907, 347; Bacillus scabiegenus Stapp, in Sorauer, Handb. d. Pflanzenkr. 5 Aufl., 2, 1928, 103; Magrou, in Hauduny et al., Diet. d. Bact. Path., 1937, 217.) Pathogenic for the beet (Beta sulgaris) Erwinia serbinowi (Potebnia) Magrou (Bacterium beticola Serbinow, Zhurm) Bolezni Rastenii, 7, 1913, 237; not Bacterium beticola Smith, Brown and Tonasend, Bur. Plant Ind., U. S. Dept. Agr, Bul. 213, 1911, 194; Bacterium serbinoui Potebnia, Kharkov Prov. Agr. Exp Sta., 1, 1915, 1; Bocillus beticola Stapp, in Sorayer, Handb. d. Pflanzenkr, 5 Auf. 2, 1928, 93; Bacillus scrbinowi Elliott, Man. of Bact. Plant Pathogens, 1930, 75, Magrou, in Hauduroy et al , Dict. d Bact. Path., 1937, 217.) Pathogenic for

the sugar bect.

Erunia urae (Kruse) Magrou. (Becillo della bacterosidei grappoh della vite, Cugini and Macchiati, Le Stariote sperimentali ital., 20, 180, 579; Bacilla urae Kruse, in Flugge, Die Mikroorgammen, 3 Auß., 2, 1890, 529; Backrum urae Chester, Ann. Rept. Del. Agr. Fey Sta., 2, 1897, 53 and 127; Magrou, in Hauduroy et al., Diet. d. Bact. Path. 1937, 220.) Pathogenie for the grap.

1937, 220.) Pathogene in the Editor Erwinia vitavora du Plessis syn Clestridium baccarnii Bergey et al , Manusl, 1st ed., 1923, 328

#### TRIBE III. SERRATEAE BERGEY, BREED AND MURRAY.

(Preprint, Manual, 5th ed , October, 1938, vi.)

Small, aerobic rods, usually producing a bright red or pink pigment on agar and gelatin. There is a single genus.

#### Genus I. Serratia Bizzo emend. Breed and Breed.\*

(Bizio, Biblioteca italiana o sia Giornale de lettera, scienze e arti, 30, 1823, 288, Zaogalactina Sette, Sull'arrossimento stanordiamo di alcune sostanza alimentose osservato nella provincia di Padova l'anno 1819. Venezia, 1824, 51, Coccobacterium Schmidt and Weis, Die Bakterien, 1902, 10, Erghrobacillus Fortineau, Compt. rend. Soc. Biol., Paria, 88, 1905, 101, Dierobactrum Enderlein, Sitzber, Gesell. Naturf. Freunde, Berlin, 1917, 300, Breed and Breed, Cent. f. Bakt., II Abt., 71, 1927, 435.) Named for Scrafino Serrati, the Italian physicist who invented a steam boat at Florence before 1787.

Small, serobic, rapidly liquefying, nitrate reducing, Gram-negative, penticibous rods which produce characteristic red pigments. White to rose red strains that lack brilliant colors are common. Coagulate and digest milk. Liquefy blood serum. Typical species produce CO<sub>2</sub> and frequently II, from glucose and other sugars; also acctic, formic, succinic and lactuc acids, acetylmethy learbined and 2,3 butylene glycol Saprophytic on decaying plant or even animal materials

The type species is Serralia marcescens Bizio

## Key to the species of genus Serratia.

- I. Pigment not especially water-soluble, readily soluble in alcohol.
  - No visible gas from glucose
     Inconspicuous pellicle, if any, on plain gelatin
    - 1 Serratia marcescens.
    - 2 Brilliant orange-red pellicle on plain gelatin
      2 Serratia indica.
  - B Produce enough H2 with the CO; from glucose to show gas in fermentation tubes
    - 1. Acetylmethylcarbinol produced
- 3 Screatia plymuthicum.
- 2. Acetylmethylcarbinol not produced 4
  - 4 Serratia Lilensis.
- 11 Pigment soluble in water and alcohol
- 5 Scrratia piscalorum.
- 1. Serratta marcescens Bizio (Polenta porporina, Biblioteca italiana, 30, 1823, 288) I From Latin, dissolving into a fluid or viscous matter
  - Synonyms: Zoagalactina imetrofa

Sette, Memoria storico-naturale sull' armasimento straordinario di alcine sostanza almentose Venezia, 8°, 1824, 51; Protococcus inetrophus Meneghini, 1838, ree Trevisan, Rend. R. Inst. Lomb.

<sup>\*</sup> Revised by Prof. Robert S. Breed, New York State Lyperment Station, Geneva, New York, Nov., 1937, further revision by Prof. Robert S. Breed, Nov., 1945.

di Sci. e Let., Ser. 2, 20, 1887, 797; Manas prodigiosa Ehrenberg, Bericht u. d. z. Bekauntmachung geeigneten Verhandlungen d. Kgl. preuss. Acad. d. Wissenschaften, 1849, 354; Palmella prodigiosa Montague, Bul. Soc. nat. et cent. d. agrie. Paris, Sér. 2, 7, 1853, 527; Micraloa prodigiosa Zanardini, 1863, see Trevisan, loc. cit., 1887, 799; Bacteridium prodigiosum Schroeter, in Cohn, Beiträge z. Biol. d. Pflanzen, 1, Heft 2, 1872, 109; Micrococcus prodigiosus Cohn, ibid., 127: Bacillus prodigiosus Flugge, Die Mikroorganismen, 1886, 284; Bacillus imetraphus Trevisan, loc. cit., 707; Bacillus marcescens De Toni and Trevisan, in Saccardo, Syllogo Fungorum, 8, 1889, 976; Bacterium prodigiosum Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 250; Liquidobacterium prodigiosum Orla-Jensen, Cent. f. Bakt., II Abt., 22, 1909, 330; Erythrobacillus prodigiosus Winslow et al., Jour. Bact., 5, 1920, 209; Dicrobactrum prodigiosum Enderlein, Bakterien Cyclogenie, 1925, 279; Salmonella marcescens and Salmonella prodigiosa Pribram, Jour. Bact., 18, 1929, 384; Chromobacterium prodigiosum Topley and Wilson, Principles of Bacteriology, 1, 1931, 402.

Description largely taken from Breed and Breed, Jour Bact., 9, 1924, 545.

Short rods, sometimes almost spherical: 0.5 by 0.5 to 1.0 micron, occurring singly and occasionally in chains of 5 or 6 elements. Mottle, with four perichous flagella. Eight to ten flagella on cells grown at 20° to 25°C (De Rossi, Rivista d'Igiene, 14, 1903, 000). Gramnegative.

Gelatin colonies: Thin, slightly granular, gray becoming red, circular, with slightly undulate margin. Liquefy the medium rather quickly.

Gelatin stab: Infundibuliform liquefaction. Sediment in liquefied medium usually red on top, white in the depth.

Agar colonies: Circular, thin, granular, white becoming red. R and S colonies

with mucoid variants (Reed, Jour. Bact., 34, 1937, 255).

Agar slant: White, smooth, moist layer, taking on an orange-red to fuchsin color in three or four days, sometimes with metallic luster.

Broth: Turbid, may form a red ring st surface or slight pellicle, and gray sedi-

Littus milk: Acid reaction with soft coagulum. A red surface growth develops. Little or no digestion takes place.

Potato: At first a white line appears, which rapidly turns red. The growth is luxuriant and frequently shows a metallic luster.

Produces acetic, formic, succibic and levolactic acid, ethyl alcobol, acetyl-

water containing urea, potassium chlonde and glucose.

Indolo not produced.

Nitrites produced from nitrates.

Formation of H<sub>2</sub>S: Produced from 03teine, cyaline or organic sulfur conpounds containing either of these molecules. Produced from sulfur but not from sulfites, sulfates or thiosulfates (Tarr, Biochem Jour., 27, 1933, 1897; 28, 1934, 192).

Acetylmetbylcarbinol is produced (Breed).

Pigment soluble in alcohol, ether, chloroform, benzol and carbon busified (Schneider, Arb. Bakt. Hochsch. Kailsruhe, 1, 1894, 210). Pigment may diffuse through the agar, i.e., shows solubility in water where strains are very deeply pigmented (Breed). Pigment not formed at 35°C.

Sodium formate broth (Stark and England, Jour. Bact., 29, 1935, 26): Cultures do not produce visible gas (Breed).

Odor of trimethylamine is produced.

Aerobic, facultative.

Optimum temperature 25° to 30°C. No growth at 37°C.

Source: Described by Bizio (loc. cit.) and Sette (loc. cit.) from growth on corn meal mush (polenta).

Habitat: Water, soil, milk, foods, silk norms and other insects

2. Serratia indica (Eisenberg) Bergey et al. (Bacillus indicus Eisenberg. Bakt. Diag., 1 Aufl., 1886, 1; Bacillus indicus ruber Flugge, Die Mikroorganismen, 2 Aufl., 1886, 285; Micrococcus indicus Koch, Berichte ucher die Reise zur Erforschung der Cholera, 1887. Bacillus ruber indicus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl. 2, 1896, 302; Bacterium ruber indicus Chester. Ann. Rept. Del. Col Agr Exp Sta , 9, 1807, 112; Eruthrobacillus indicus Holland, Jour. Bact., 5, 1920, 218, Bergey et al., Manual, 1st cd , 1923, 88, Breed and Breed, Jour of Bact . 11, 1926, 76, Chromobacterium indicum Topley and Wilson, Princ Bact and Immun. 1, 1931, 402.) From Latin indicus, of India.

Small rods: 0.5 by 10 to 15 microns Motile with four peritrichous flagella Gram-negative.

Gelatin colonies: Resemble those of Serratia marcescens.

Gelatin stah, Liquefied rather quickly Brilliant orange-red pellicle on plain gelatin,

Agar colonies. Pink, with slightly serrate margin, spreading, with green irridescence.

Agar slant: Luxuriant, dirty-white layer. Pigment produced best in alkaline media.

Broth: Turbid, with white sediment Litmus milk; Acid and congulated

Digestion complete in 10 days. Potato; Luxuriant growth with or with-

out pigment formation. Produces same products (except IIs)

from plucose as does Serratia marcescens

(Pederson and Breed, Jour. Bact., 16. 1928, 183).

Indole not produced. Natrites produced from nitrates.

Growth with pigment production in distilled water containing urea, potassium chloride and glucose.

Blood serum liquefied. Odor of trimethylamine.

Sodium formate broth Cultures do not

produce visible gas (Breed), Pathogenic for laboratory animals.

Acetylmethylcarhinol is produced (Breed).

Aerohic, facultative.

Optimum temperature 25° to 35°C. No growth at 37°C.

Cultures of this organism lose their ability to produce the orange-red pellicle on gelatin and then become practically indistinguishable from cultures of Serratia marcescens. This would indicate that this so-called species is a rough strain of the former species (Breed). See Reed (Jour. Bact , 34, 1937, 255) for a discussion of dissociation phenomena in this cenus.

Source. Isolated from alimentary tract of a Java age in India; also from milk can from Ithaca, N. Y.

Habitat. Presumably widely distributed.

Apparently the following non-gelatin hauefying strain belongs with this species Subcultures that are claimed to be derived from the original now liquely relatin.

2a, Serratia miquelii Bergey et al. (Named Bacillus ruber by Miquel and described in a letter to Hefferan, Cent. f. Bakt . II Abt . 11, 1903, 402; Erythrobacillus ruber Holland, Jour. Bact., 5, 1920, 223; Bergey et al , Manual, 1st ed., 1923, 95 )

Isolated from water by Miquel.

3. Serratia plymuthicum (Lehmann and Neumann) Bergey et al. (Roter

Bacillus aus Plymouth, Fischer, Zeitschr. f. Hyg., 2, 1887, 74; Bacterium plymuthicum Lehmann and Neumann, Bukt. Diag., 1 Aufl., 2, 1896, 264; Bacillus plymouthensis Migula, Syst. d. Bukt., 2, 1900, 849; Erythrobacillus plymouthensis Holland, Jour. Bact., 5, 1920, 220; Bergey et al., Manual, 1st ed., 1923, 88.) Latinized from Plymouth, England.

Distinct rods: 0.6 by 1.5 to 2.0 microns with rounded ends, occurring singly and in short chains. Motile with peritrichous flagella. Grom-negative.

Gelatin colonies: Like Serratia marcescens. Original culture mucoid.

Gelatin stab: Crateriform liquefaction. Liquefaction as in Serratia marcescens. Agar colonies: Like mucoid varieties of Serratia marcescens.

Agar slant: Sometimes show metallic luster. Pigment as in Serratia marces-

Broth : Like Serratia marcescens.

Litmus milk: Acid and coagulated.
Potato Growth violet pink, with or

without metallic luster.

Gas from glucose, lactose and sucrose,
70 to 80 per cent of it CO<sub>2</sub> Remainder
is H<sub>2</sub> Gas is also produced in asparagine

solutions. Strong feeal odor produced.

Blood serum liquefied.

Acetylmethylearbinol is produced (Breed).

Sodium formate broth: Cultures produce abundant gas (Breed).

Pigment soluble in alcohol, ether and sometimes water.

Acrobic, facultative.

Optimum temperature 30°C.

Source: From water supply of Plymouth, England.

Habitat: Water and various foods.

 Serratia kilensis (Lehmann and Ncumann) Bergey et al. (Bacterium h, Breunig, Inaug. Diss., Kiel, 1888; Bacillus ruber ballteus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 303; Bacterium kitiense Lehmann and Neumann, Bakt. Diag., I Aud., 2, 1806, 263; Bacterium ruber baltieus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta. 9, 1897, 142; Bacillus klitensts Migula, Syst. d. Bakt., 2, 1900, 817; Erythrobacillus klitensis Indlund, Jour. Bact., 6, 1920, 218; Bergey et al., Manual, 1st ed., 1923, 90; Chromobacterium kielense Topley and Wilson, Princip. Bact. and Immun., 1, 1931, 400.) From Kiel, a city on the Baltie Sea.

Description taken from Kruse (loc cit.) and Bergey et al. (loc. cit.).

Slender rods: 0 7 to 0.8 by 2 5 to 50 microns, occurring singly. Mottle with four peritrichous flagella. Gram-negative.

Deep gelatin colonies: Bright yellow Gelatin liquefied slowly, usually becom-

ing rose-red.

Glucose gelatin stab: Rapid liquefaction. Occasional gas bubbles (Breed) Agar colonies: Small, red becoming magenta, smooth.

Agar slant: Bright red becoming darker

in old cultures

Agar stab: Turbid strongly pigmented
water of condensation.

Broth: Turbid. Usually reddened. Litmus milk: Acid; at 20°C, coagulated slowly and pigment produced; at 35°C, coagulated rapidly and no pigment produced.

Potato: Slight red growth, becoming

luxuriant and darker. Indole not formed.

Nitrites and free nitrogen produced from nitrates.

Blood scrum liquefied.

Acid and gas from earbohydrates (Lehmann and Neumann, loc. cit.). Gas from glucose, lactose and sucrose, 20 to 30 per cent of it CO; (Bergey). Inactive lactic acid produced and not more than trace of acetylmethylcarbinol or 2, 3 butylene glycol (Pederson and Breed, Jour. Bact., 16, 1928, 183).

Sodium formate broth: Gas produced

(Breed).

Acctylmethylcarbinol not produced by the Král culture (Breed)

Pigment formed at 37°C Pigment especially soluble in alcohol
Optimum temperature 30°C.

Aerobic.

Distinctive characters It is not certain whether Breunig's original culture was a heavily pigmented strain of Serratia marcescens, or whether it was of the type described above. Cultures of both types have been widely distributed as the Kiel bacillus. Descriptions drawn up by Kruse (loc. cit.) and Lehmann and Neumann (loc eit ) in 1896 state that this bacterium produces visible gas, while Migula in 1900 gives a description which fits Serratia marcescens Moreover, cultures obtained under this name from various laboratories in Europe and America are sometimes of one type and seme tunes of the other As the Kral culture distributed as Racillus ruber balticus is widely known and has now been shown to differ from Serratia marcescens in that it is a distinct rad in ordinary media, forms visible gas from earbohydrates and even more abundant cas from sodium formate media, the name Serratia kilensis is used here for the Kral culture Serratia Lileners is a distinct rod like Serratia plymuthicum, but fails to produce acetylmethylearband. This use of the name Serratia kilensis given here also accords with the description drawn up by Bergey for the first edition of the Manual based on the study of a culture which he obtained many years previously from Lurope (Breed).

Source: From water at Kiel, Germany Habitat: Presumably widely distributed

5 Serratla piscatorum (Lehnasuu and Marobe rouge de la serdine, Du Pois Santi-Stvin, Ann Inst Past., 8, 1894, 155, Bacteroum piscatorum Lehnann and Neumann, Bikt Dieg. 1 Aufl., 2, 1896, 263, Bacillus ruler vardinac Kruse, in Filegge, Die Mikroorguusmen, 3 Aufl., 2, 1896, 302; Bacterium ruber sardinae Chester, Ann. Rept. Del. Co. Agr. Exp. Sta., 9, 1897, 112; Bacillus sardinae Migula, Syst. d. Bakt. 2, 1900, 882; Bacillus prisadorus Chester, Man Determ. Bact., 1901, 257.) From Latin prisadorum, of fishermen.

Short rods: 0.5 by 0.6 micron, occurring in pairs, sometimes in fours or (in broth) in long filaments. Actively motile, Gram-negative.

Gelatin colonies Small, yellowish-gray becoming pink, very slimy. Carminered pellicle. Liquefaction.

Gelatin atab Bapid liquefaction, Grayish pellicle which becomes red after 24 hours and later precipitates. Simy, Agar colonies Dull, white to pinkish growth

Broth Rapid turbidity. Thick, slimy, white pellicle which later turns red. Purplish sediment Liquid becomes pink and syrupy. In old cultures the broth is brown

Potato At 37° to 39°C, red pigment visible after 8 hours. At room temperatures growth is first white, slimy, later met.

Strong odor of trimethylamine.

Distinctive characters: Pigment soluble in alcohol, more soluble in nater Good pigment production at 37°C. Slimi-

Source Isolated in 1893 from a low of oil-packed sardines at a canning-factory in France Also found in the red pus from fishermen and sardine-lactory-workers sulfering from leions. In these levons, this organism is associated with an anaerobe, but by itself it is not pathogenic.

Habitat Presumably widely dis-

Appendix: Serratia marcescens has Irequently been described under other names, particularly where brilliantly pigmented cultures have been found. Some of these and other related species are heted below. It is known that white

strains of these organisms occur in nature but these strains when found have probably been placed in non-chromogenic genera of the family Enterobacteriaceae.

Bacillus ruber Frank, (Frank, in Cohn, Beitr. z. Biol. d. Pflank, I, Heft 3, 1876, 181; not Bacillus ruber Zimmernann, Bakt. unserer Trink- u. Nutzwässer, Chemnitz, I, 1890, 24; not Bacillus ruber Miquel, see Cent. f. Bakt., II Abt., II, 1903, 402; Backerium ruber Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 113.) Grew in a warm place on rice ecoked in chicken broth.

Bacillus subkiliensis Petrow. (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 273.) Dust contamination from air. Reported to resemble Bacillus killensis.

Dacterium aurescens Part. (Proc. Soc. Exp. Biol. and Med., 55, 1937, 653). A reddish-brown organism. This and the reddish-brown organism described by Tittsler (Jour. Bact., 55, 1937, 450), which are regarded as pigmented variants of Escherichia coli, resemble the organisms in Serratia closely but do not liquefy gelatin. From water.

Seratia amylorubra (Hefferan) Bergey et al. (Bacillus amyloruber Hefferan, Cent. f. Bakt., II Abt., 11, 1903. 313; Erythrobacillus amyloruber Holland, Jour. Bact., 5, 1920, 217, Bergey et al., Manual, 1st ed., 1923, 90) From Mississuppi River water and buttermils.

Serratia esseyana Combe. (Thèse, École de Méd. Univ. Besançon, 1934, 1.) From well water at Essey. A study of an authentic culture shows this to be Serratia marcescens (Breed).

Serratia fuchsina (Boekhout and De Vries) Bergey et al. (Bacıllus fuchsinus Boekhout and DeVries, Cent. f. Bakt., II Abt., 4, 1898, 497; Eruhrobacillus fuchsinus Holland, Jour. Bact., 6, 1920, 218; Bergey et al., Manual, 1st ed., 1923, 91.) Bacıllus fuchsinus Migula. (Der rote Bacıllus, Lustig, Diag. d. Bakterien d. Wassers, 1893, 72; Migula, Syst. d. Bakt., 2, 1900, 853.) Although these two organisms were named independently

from different cultures, they were undoubtedly identical. The original cultures of these species appear to have been heavy pigmented strains of Stratia marcescens showing a metallic luster. No authentic cultures are available. From water.

Serrolia guituris Jan. (Bull. Soc. Sci. de Bretagne, 16, 1939, 34.) From sputum. Claimed to be different from Serratia marcescens on the ground that it will grow on an asparagine medium and that it reduces molybdates actively.

Serrotia marinorubra Zoboll and Upham, (Bull. Scripps Inst. Oceanography, LaJolla, 5, 1914, 255) From sea water. Grew only on sea water media when first isolated but later a culture studied by Breed (1944) became adapted to growth on ordinary media and then showed the characteristics of Serratia marcescens.

Serratia miniacca (Zimmermann) Bergey et al. (Bacillus miniaccus Zimmermann, Die Bakterien unserer Trink: und Nutznässer, Chemnitz, 1, 1890, 46; Erythrobacillus miniaccus Holland, Journ Bact., 5, 1920, 219, Bergey et al., Manual lat ed., 1923, 90.) Probably a heavily pigmented strain of Serratia marceaccus or Serratio plymuthicum showing metallic luster. From water.

Serrata pyoseplica (Fortineau) Bergey et al. (Erythrobacillus pyoseplicus Fortineau, Thesis, Faculty of Medicius, Paris, 1904; abstract in Bull. Inst Pasteur, 3, 1905, 13; Bergey et al., Manual, lst ed., 1923, 80.) No constant differences have been detected between Serratia marcescens and authentic cultures of Serratua pyoseptica. From the shirt of a hospital patient. Pathogenic for guinea pigs and birds. Forms a soluble toxin.

Serratia rubidaca Stapp. (Bacterium rubidacum Stapp, Cent. (. Bakt., II Abt., 102, 1940, 251; 15td., 253) From surface of plants and in composts. Characters much like those of Serratia marcescens.

Serratia ruittecens (Hefferan) Bergey et al. (Bacillus rutilescens Hefferan, Cent. f. Bakt., II Abt., II, 1903, 313, Erythrobacillus ruitlescens Holland, Jour. Bact., 5, 1902, 202) Bergey et al., Manual, 1st ed., 1923, 91.) The characters given do not distinguish this species from strains of Serratia marcescens that have nearly lost their power of pigment production except that it is reported to grow rapidly at 37°C. No authentic endures appear to be available. From Mississuppi River water.

Scratia rutilis (Hefferan) Bergey et al. (Bacıllus rutilis Hefferan, Cent. f. Bakt., II Abt., 11, 1903, 313, Erythrobacillus rutilis Holland, Jour. Bact., 5, 1920, 220; Bergey et al., 1st ed., 1923, 94.) The original of this species appears to have been a heavily pigmented strain of Serrata marcescens or of Serratia plymuthicum. No characters are given that distinguish it from these species and no cultures appear to be available. From Hinois River water.

Serratia stercoraria Jan. (Bull. Soc. Sci de Bretagne, 16, 1993, 34) From feces. Claimed to be different from Serratia marcescens because it attacks lactose, maltose and mannitol and reduces molybdates even more actively than Serratia gutturis.

## TRIBE IV. PROTEAE CASTELLANI AND CHALMERS.

(Manual of Trop. Med., 3rd ed., 1919, 932.)

Ferments glucose but not lactose with formation of acid and usually visible gas There is a single genus.

## Genus I. Protens Houser \*

(Hauser, Sitzber. d phys.-med. Sozietat zu Erlangen, 1885, 156; Liquidobacterium Jensen, Cent. f. Bakt., II Abt., 22, 1909, 337; Spiriling Hueppe, Wiesbaden, 1886, 146; Eisenbergia Enderlein, Sitzber. Ges. Naturf. Freunde, Berlin, 1917, 315.) From Latin, having a changeable form.

Straight rods. Gram-negative. Generally actively motile at 25°C, motility may be weak or absent at 37°C, peritrichous, occasionally very numerous flagella. Generally produce amoebold colonies, swarming phenomenon, on moist medium. Marked pleamorphism characteristic only of very young, actively swarming cultures. Ferment glucose and usually sucrose but not lactose. Three species in fermentable carbobydrates produce small gas volumes even after prolonged incubation and an occasional culture does not produce gas. One species usually produces acid only. Urea decomposed and trimethylamine oxide reduced by all species

The type species is Proteus rulgaris Hauser.

## Key to the species of genus Proteus.

- I. No action on mannitol.
  - A Acid and gas from sucrose. 1. Acid and gas from maltose.
    - a Indole formed.

- 1. Proteus vulgaris.
- B. Acid and gas from sucrose (delayed).
  - 1. No action on maltose
    - a Indole not formed.
- 2. Proteus mirabilis.
- C. No action on sucrose (ordinarily).
  - 1. No action on maltose.
    - a. Indole formed.

- 3. Proteus morganii.
- II. Acid, occasionally a bubble of gas, from manuitol.
  - A Acid from sucrose (delayed) 1. No action on maltose.

    - a. Indole formed.

4. Proteus rellgeri.

1. Proteus vulgaris Hauser. (Hauser, Sitzungsber. d. phys.-mediz Sozietat zu Erlangen, 1885, 156, Bacillus proteus

Trevisan, I generi e le specie delle fatterraces, 1889, 17; Bacterium sulgare Lehmann and Neumann, Bakt. Disg.

<sup>\*</sup> Originally revised by Prof M. W. Yale, New York State Experiment Station, Geneva, New York, Nov. 1935; revised by Prof. C A. Stuart and Dr. Robert Rusligian, Brown University, Providence, Rhode Island, May, 1943

1 Aufl., 2, 1896, 243; Bacillus proteus tulgaris Kruse, in Flugge, Die Mikroorganismen, 2, 1896, 272, Bactersunt (Proteus) vulgaris Chester, Ann Rept Del. Col. Agr. Exp. Sta , 9, 1897, 101, Bacıllus vuloarıs Migula, Syst d Bakt . 2, 1000, 707; Bacterium proteus anin dologenes van Loghem, Ann. Inst Past, 32, 1018, 295; Bacillus proteus-vulgaris Holland, Jour. Bact., 5, 1920, 220.) From Latin, common.

Hauser described Proteus vulgaris as a rapid gelatin liquefier and Proteus mirobilis as a slow liquefier. Wenner and Retiger (Jour. Bact . 4, 1919, 332) found the property of liquelying gelatin too variable to serve as a basis for separation of species. They suggested that this differentiating character be set aside and the two species differentiated on the basis of maltose fermentation, the species fermenting the sugar receiving the name Proteus vulgaris and the species failing to attack it. Proteus mirabilis This suggestion was accepted by Bergey et al . Manual, 1st ed., 1923 and Weldin, lows Jour. Sci , 1, 1927, 147, and their work was confirmed by Rustigian and Stuart (Jour. Baet., 45, 1913, 198) and by Thornton (Jour. Bact , 48, 1944, 123) Also see Moltke (Contributions to the Characterization and Systematic Classification of Bac proteus vulgaris (Hauser), Levin and Munksgaard, Copenhagen, 1927, 156).

Rods . 0.5 to 1.0 by 1 0 to 3 6 microns, occurring singly, in pairs and frequently in long chains. Actively motile, with

peritrichous flagella Gram-negative Gelitin colonies 1rregular, spreading,

rapidly liquefying. Gelatin stab . Rapid, stratiform liquefaction.

Agar colonies · Opaque, gray, spreading Agar slant. Thin, blush gray, spreading over entire surface

Broth: Marked turbidity, usually with a thin pellicle.

Latmus milk: Shehtly acid, becoming

markedly alkaline. Quick pentonization

Potato: Abundant, creamy to rellowish grav growth, becoming brown. Indole formed.

Nitrates produced from nitrates. Acetylmethylcarbinol not formed

Acid and gas from glucose, fructose, galactose, maltose and sucrose No acid or gas from dextrin, lactore or mannitol. See Moltke (loc. cit.) for other fermentation characters Ratio II, to CO, is 1:1 (Speek and Stark, Jour Bact., 44, 1942, GS7)

Putrefactive odor produced. Sodium citrate usually utilized as solo source of carbon.

Formation of Il-S: Produced from eysteine, cystine or organic sulfur compounds containing cities of these molecules Produced from sulfur and thiosulfates (Tarr, Biochem, Jour., 27, 1933, 1869, 28, 1934, 192). Lead acetate turned brown.

Aerobie, facultative,

Optimizin temperature 37°C

Distinctive characters X-Strains of Weil and Felix. Lehmann-Neumann-Breed, Determinative Bact , Eng. Trans., 7th ed . 2, 1931, 493 "The discovery of proteus strains which may be agglutinated by typhus serum is of very great importance. These are the so-called X-strains from typhus patients found by Weil and Felix. They first cultivated strains X and X2 from the urine of typhus patients and later the famous X11. The two former were agglutinated weakly, the latter strongly (up to 1:50,000). The diagnosis of typhus by agglutination with strain X proved to be excellent and the reaction took place in the serum of almost 100 per cent of those suffering from the discree . . The typhus strains of proteus have recently been divided into the tun types of Februard West, the H forms and the O forms. The former grows as a thin oraque film, the Litter lacks this character and grows as non-spreading slimy colonies; frequently nithout dis-

tinct flagella...." (For further description of H and O forms see Maltke. loc. cit.)

The X, and X1, strains mostly ferment maltose.

Source: From putrid meat infusions and abscesses.

Habitat: Putrefying materials.

2. Proteus mirabilis Hauser. (Hauser, Sitzungsber, d. phys.-mediz. Sozietāt zu Erlangen, 1885, 156; Bacillus mirabilis. Trevisan, I generi e le specie delle Batteriacee, 1889, 17; Bacillus proteus mirabilis Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 276; Bacterium mirabilis Chester, Del. Coll. Agr. Exp. Sta., 9th Ann. Rept., 1897, 101; Bacillus pseudoramosus Migula, Syst. d. Bakt., 2, 1900, 817; not Bacillus pseudoramosus Distaso, Cent. f. Bakt., I Abt., Orig., 62, 1012, 441; Bacillus proteus-mirabilis Holland, Jour. Bact , 5, 1920, 220.) From Latin mirabilis, wonderful.

Short rods: 0.5 tn 0.6 by 1.0 to 3.0 microns, occurring singly, in pairs and frequently in long claims. Motile, possessing peritrichous flagells. Gram-neg-

Gelatin colonies: Irregular, spreading. Gelatin stab: Slow, stratiform lique-

Agar colonies: Gray, irregular, spread-

ing. Agar slant . Thin, bluish-gray, spread-

ing over surface. Broth: Turbid, with thin gray pellicle

and sediment. Litmus milk: Slightly neid, becoming

nikaline, peptonized. Potato: Dirty-gray, spreading growth.

Indole not formed. Acctylmethylcarbinol frequently pro-

duced weakly. Nitrites produced from nitrates.

Acid and gas from glucose, fructose and galactose. Acid and gas usually produced slowly from sucrose. Nn acid nr gas from lactose, maltose, dextrin or mannitol.

The XK strains are mostly maltose negative.

Putrefactive odor preduced.

Hydrogen sulfide is produced. Sodium citrate usually utilized as a sole source of carbon.

Aerobic, facultative.

Optimum temperature 37°C.

Source: From putrid meat, infusions and abscesses. Also reported as a cause of gastroenteritis (Cherry and Barnes, Amer. Jour. Pub. Health, 36, 1946, 454).

Habitat: Putrefying materials.

3. Proteus morganil (Winslow et al.) Rauss. (Organism No. 1, Morgan, Brit. Med. Jour., 1, 1906, 905; Bacillus morgani Winslow, Kligler and Rothberg, Jour. Bact., 4, 1919, 481; Bacterium morgani Holland, Jour. Bact., 5, 1920, 215; Bacterium metacoli or Escherichia morgani Thiotta, Jour. Inf. Dis., 45, 1928, 349; Salmonella morgani Castellani and Chalmers, Man. Trop. Med., 1919, 939; Rauss, Jour. Path. and Bact., 42, 1936, 183; Morganella morganii Fulton, Jour. Bact, 46, 1943, 81; regarded by Fulton as the type species of the genus Morganella) Named for Morgan, who first isolated this preamism.

Common name: Morgan's bacillus, type 1.

Rnds: 0.4 to 0 6 by 1.0 to 2.0 microns, occurring singly. Motile with pentrichous flagella. Sce Rauss, loc. cit., for discussion of flagellation and relation to the swarming characteristic. Gramnegative.

Gelatin colonies: Bluish-gray, homogeneous, smooth, entire.

Gelatin stab: No liquefaction.

Agar colonies: Grayish or bluish-white, circular, entire.

Agar slant: Grayish-white, smooth, glistening growth.

Broth: Turbid.

Litmus milk: Neutral, or becoming alkaline.

Potato: Dirty-white, limited growth.

Indole is formed.

Nitrites are produced from nitrates.
Acctylmethylcarbinol not formed.

Acid and a small amount of gas from glucose, fructose, galactose and mannose Rarely from xylose. Does not attack lactose, sucrose, maltose, arabinose, raffinose, devtrin, sahein, mannutol, dulctiol, sorbiblo, adoptiol or inositol

Hydrogen sulfide not produced.

Sodium citrate not utilized as sole source of carbon.

Aerobic, facultative.

Optimum temperature 37°C

Source: Isolated from the feces of Infants with summer diarrhea.

Habitat: In intestinal canal in normal or duarrheal stools.

4. Proteus rettger! (Hadley et al ) Rustigian and Stuart. (Bacterium rettgers Hadley, Elkins and Caldwell, Rhode Island Agr. Exp. Sta. Bull 174, 1918, 169, Bacillus rettgeri St. John-Brooks and Rhodes, Jour. Path, and Bact . 26, 1923. 431; Eberthella rettgeri Bergey et al , Manual, lat ed., 1923, 232; Shigella rettger: Weldin, Iowa State College Jour Sci , 1, 1927, 181; Atypical entene organisms of the Shigella group, Cope and Kilander, Amer Jour Pub Health, 52, 1942, 352; Proteus enterious Rustigian and Stuart, Jour Bact , 45, 1943, 198; Rustigian and Stuart, Proc Soc Exp Biol. and Med., 55, 1943, 211 ) Named for L. F. Rettger, the American bacterrologist, who isolated this species in 1901.

Rods: 0 5 to 0 8 micron long, occurring singly, in pairs and occasionally in chains. Usually non-motile at 37°C, but actively motile variants possessing peritrichous flagella can be obtained at 25°C. Gramnegative.

Gehtin colomes: Small, grayish, translucent, entire.

Gelatin stab: No liquefaction.

Agar colonies: Small, grayish, translucent, entire; under suitable conditions some strains show marked spreading. Agar slant: Filiform to echinulate, grayish, thin, moist, translucent. Broth: Turbid with flocculent to

viscid sediment.

Litmus milk: Alkaline in eight days, becoming translucent.

Potato: Luxuriant, grayish growth. Acid and occasionally slight gas from glucose, fructose, galactose and mannitol. Sahem may or may not be fermented. Slow and sometimes weak acid in sucrose. Lectose and maltose not fermented.

Indole 18 formed.

Netrates are produced from nitrates. Acetylmethylearbinol not formed. Hydrogen sulfide not produced.

Sodium citrate utilized as sole source of earbon.

Aerobic, facultative.

Optimum temperature 37°C.

Source: Originally isolated from cholera-like epidemic among chickens; recently isolated from sporadic and epidemic gastroenteritis patients.

Habitat: Fowl typhoid and some cholera-like diseases of birds.

Appendix: Acceptance of gelatin liquefaction and fermentation of glucose and sucrose but not lactose as the cardinal characteristics of Proteus without refcrence to urease production and small cas volumes has resulted in some cultures of Paracoloboctrum (Borman et al., Jour Bact., 48, 1944, 361) being described as Proteus (Rustigian and Stuart, Jour. Bact . 49, 1945, 419) Included in the amendix are species of Proteus whose taxonomic position is not clear. Where descriptions permit, the probable taxonomic position of the organism is indicated. For purposes of reference, orgamesms are also included which do not now merit species rank in the genus Proteus and organisms which will now be found in another genus.

Bacillus agglomerans Beijerinck. (Botan. Zeitung. 40, 1888, 740 or 749.) From nodules on the roots of red clover. Colonies like those of Proteus. Bacillus murisepticus pleomorphus Karlinski. (Karlinski, Cent. f. Bakt., 5, 1889, 193; Proteus of Karlinski, Sentberg, Man. of Bact., 1893, 460) From a urine discharge and from absessess in the uterus. Sternberg regards this species as probably identical with Proteus vulgars Hauser.

Flavobacterium meningitidis Hauduroy et al. (Bacillus liteus liquefaciens Hinduroy, Duhamel, Ehringer and Mondin, Compt. rend Soc. Bod., Paris, 110, 1932, 362; Hauduroy et al., Dict. d. Bact. Path., 1937, 236) Related to this species but differing in that it ferments lactose is the following. Bacterium coli var. liteoliquefaciens Lehmann and Levy, in Lehmann and Keymann, Bakt. Diag., 4 Aufl., 2, 1907, 34! (Bacillus coli var. luteoliquefaciens Hauduroy, Duhamel, Ehringer and Mondin, loc. cit., 1932, 3631).

Proteus alvercola Serbinow. (Jour. Microbiol., Petrograd, 2, 1915, 19.) From an infectious diarrhoea of honey

bees (Apis mellifera).

Proteus americanus Pacheco. (Sciencia Medica, 6, 1928.) From the blood of patients with liver abscesses Assis (Brasil Medico, No. 42-45, 1934, 35), St. John-Brooks and Rhodes (3rd Internat. Cong. for Microbiology, Rept. of Proc., 1939, 167), Rustigan and Stuart (Jour. Bact., 45, 1943, 193) and Thornton (Jour. Bact., 48, 1944, 123) agree that Proteus americanus is Proteus mirabilis. See Manual, 5th ed., 1939, 434 for a description of this species.

Proteus ammoniae Magath, (Magath, Jour Inf. Dis., 43, 1928, 181; Salmonella ammoniae Hager and Magath, Jour. Amer. Med Assn., 85, 1925, 1352.) From urine in cystitis. St. John-Brooks and Rhodes (364 Internat. Congr. for Microbiology, Rept of Proc., 1939, 167), Levine (Jour. Bact., 43, 1942, 33), Rustigian and Stuart (Jour. Bact., 43, 1943, 193) and Thornton (Jour. Bact., 48, 1944, 123) agree that Proteus ammoniae is Proteus mirabilis See Manual, 5th ed., 1939,

434 for a description of this species. See Fulton, Jour. Bact., 51, 1946, 685 for the view that *Proteus ammoniae* is a valid species.

Proleus bombycis Bergey et al. (A Gram-negative hacillus, Glaser, Jour. Bact., 9, 1924, 344; Bacterium bombyci-vorum Lebmann and Neumann, Bakl. Diag., 7 Aufi., 2, 1927, 445; Aerobadr bombycis Bergey et al., Manual, 361 ed., 1934, 365.) From disensed silk norms (Bombyz mori). Proteus bombycis spears to be a strain of Paracolobadrum aerogenoides Borman et al. See Manual, 5th ed., 1939, 436 for a description of this species.

Proteus diffuens (Castellani) Castellani and Chalmers. (Bacillus diffuent Castellani, 1915; Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 913.) From gastroenteritis patients This may be a biochemical variant of Proteus mirabilis.

Proteus henricensis Shaw. (Sci., 65, 1927, 477.) From putrefying materials Said to be related to Proteus diffuens

Proteus infantum (Weidin and Levius)
Weidin. (Dean, Med. Jour. Australia,
1, 1920, 27; Boelerium infantum Weldin
and Levine, Abst. Bact., 7, 1923, 13;
Weldin, Jowa State Coll. Jour. Sci., 1,
1926, 148.) From urine and feces of an
infant.

Proteus insecticolens Steinhaus. (50sr. Bact., 42, 1941, 753.) From the stomach of the milkweed bug (Oncopellus fasciatus). This appears to be a strate of Paracolobactrum intermedium Borman et al.

Proteus melanocogenes Miles and Halnan. (Jour. Hyg., 57, 1937, 79) From eggs showing black rot. This does not appear to be a member of the genus Proteus.

Proleus metadifficers (Castellani) Castellani and Chalmers. (Bacillus metadiffuens Castellani, 1915; Castellani and Chalmers, Manual Trop. Med., 1919, 943.) From gastroenteritis patients This does not appear to be a member of the genus Proteus

Proteus nadson:: Lobik. (Discases of Plants, St. Petersburg, 9, 1915, 67.) From decomposed potatoes and tomatoes. This does not appear to be a member of the genus Proteus

Proteus noctuarum (White) Bergey et al (Bacillus noctuarum White, Jour Agr. Res. 26, 1923, 488; Escherichan noctuari Bergey et al., Manual, 3rd ed., 1930, 327; Bergey et al., Manual, 3rd ed., 1934, 363.) A cause of cutworm (Fam Noctuade) septicema Culturally identical with but scrologically different from Proteus soluments.

Proteus odorans Pribram. (Baeterium aquatite odorans von Rigier, Hyg. Rund, 12, 1902, 479; Pribram, Klassifikation der Schizomyceten, Leipzig and Wien, 1933, 73) From bottled mineral waters Aromatic odor in milk.

Proteus paraamericanus Magalh les and Aragão (Brasil Medico, 47, 1933, 815) From nrine. Assis (Brasil Medico, No 42-45, 1931, 35) states that this is Proteus mirabilis.

Proteus paradifluens (Castellani) Castellani and Chalmers. (Bactilus paradiffuens Castellani; Castellani and Chalmers, Manual Trop Med., 3rd ed., 1919, 913) This appears to be identical with Proteus mirabilis

Proteus paramorganii Castellani and Chalmers (Man. Trop Med., 3rd ed., 1919, 913.) This is an H form of Proteus marganii

Proteus photuris Brown (Amer Museum Nov, No. 251, 1927, 9) From imminous organ of the firefly (Photuris pennsyljanicus). This does not appear to be a member of the genus Proteus.

Proteus pisceidus reraicolor Bales and Itiegler (Bales and Riegler, Cent. f Bakt., I Aht., Orig., 33, 1902-03, 419, Bacillus pisceidus reraicolor Nepveur, Thèse, Inc. Pharm., Paris, 1920, 114) From diseased carry (Cyprinus carpio) Resembles Proteus culoans

Proteus pseudocaleries Assis (Jour.

Hyr., 27, 1927, 1983.) Rustigan and Stuart (Proc. Soc. Exper Biol. and Med., 53, 1943, 211) state that this is a paracolon organism, presumably Paracolobactrum coliforme Borman et al. See Manual, 5th ed., 1939, 435 for a description of this species

Proteus recteolens Steinhaus. (Jour. Bact , 42, 1941, 763) From pi lorus and rectum of the milk weed bug (Oncopelius fasciatus). This appears to be a strain of Paracolobactrum intermedium Borman et al.

Proteus sphingulus (White) Bergey et al (Becellus sphingulus Wlite, Jour. Agr Res, 20, 1923, 40; Escherichia sphingulus Bergey et al, Manual, 3rd ed., 1930, 327, Bergey et al, Manual, 4rd ed., 1931, 305 ) A cause of hormorm septiecma (Protoparce sezta Johan, and P guinguemeculata Haw.) See Manual, 6th ed., 1930, 605 for a description of this species with (loc. ett.) regards this species as possibly identical with Coccobactillus aerithorum d'Herelle.

Proteus sulfureus Illoichemihoff. (Holschemihoff., 10rtschr d. Med., 7, 1889, 201 and Ann do Mierogr, 1, 1889-1889, 237; Baeillus Inndenborns Trevisan, I generi e lo specie delle Batterinece, 1889, 17; Baeillus sulfureus Migula, Syst d Balt, 2, 1900, 608; not Baeillus sulfureus Trevisan, I generi e le specie delle Batteriace, 1889, 17) From water. Similar to or perhaps identical with Proteus sulgarus Tradices Ills

Proteus sp Steinhaus. (Jour. Bact., 4z, 1941, 761) This organism appears to be a strain of Paracolobactrum intermedium Borman et al.

Proteus sp Warren and Lamb. (Jour. Med. Res., 44, 1921, 375) From feces and thood of patient with a fatal infection. This organism does not appear to be a member of the genus Proteus.

Urolacillus liquefaciens septicus Krogius. (Compt. rend Soc Boli, Paris, 2, 1850, 65.) Regarded by Lehmann and Neumann (Bakt Diag., 1 Aufl., 2, 1896, 213) as a synonym of Proteus vulgaris. The nomenclature used in the present edition of the Manual is slightly modified from that used in the fifth edition. The form adopted is in accordance with the view that the recognition of similar antigenie structures really identifies scrotypes rather than species. In a way, scrotypes are varieties in a taxonomic sense, though his horticultural varieties in higher plants, they do not exactly correspond with varieties as usually defined by taxonomists. Where cultural differences rather than antigenie structure have been used to subdivide species, these subdivisions are designated as varieties.

As it is not clear as yet how many and what species will eventually be recognized, the form Salmonella sp. has been used as before to indicate that the serotypes belong to species in the genus Salmonella which are not yet definitely defined. Geographic and other proper names are used to designate types as these have been used ettersively in the literature. They have an historic significance and are not as easily confused as are letters and numbers. No Latin endings have been used for these place names as this might indicate that the serotype names are accepted as species names.

The genus Eberthella has been combined with the genus Salmonella as recommended by Schutze et al. (loc. cit.). With the exception of the typhoid organism, other species previously listed in Eberthella appear not to exist in type culture collections. As cultures are not available for study, these species are merely listed in an appearance to the genus Salmonella.

The type species is Salmonella choleraesuis (Smith) Weldin.

The table on pages 495 to 500 is used in place of the usual key.

Serulogical I yper in the Genus Salmonella. Intigenic Structure

| Salmonella paratyph. Salmonella seathmetlera Salmonella estalmunellera Salmonella et (T.Spa Mony) Salmonella et (T.Spa Mony) Salmonella et (T.Spa Mony) Salmonella et (T.Spa Mondella Salmonella et (T.Spa Salmonella Salmonella et (T.Spa Sal | (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)  | 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4  | Phase 2<br>[1, 2]<br>1, 2, 3, 3, 1, 2, 3<br>1, 2, 3<br>1, 2, 3<br>1, 2, 3<br>1, 2, 3<br>1, 2, 3 |
|--|--|--|---|
| An A   | 19, 11, X1<br>19, 11, X1<br>19, 12, 13, X1<br>19, 13, 13, X1<br>19, 13, 13, X1<br>19, 13, 13, X1<br>19, X1<br>19 | 4 44" 74 7 6 6 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4   | 11, 21, 12, 13, 13, 13, 13, 13, 13, 13, 13, 13, 13  |
| utlers po Atony) pratriam pre Kolin) pre Kolin) pre Blandey) pre Greater pre Creater pre Creater   | 5×5×××55 ×   | 44" X4 7 0 0 4 0<br>4 0 0 4 0<br>4 0 4   | (1, 2)<br>(1, 2, 1, 1, 2)<br>(1, 1, 2, 3, 3, 3, 1, 1, 2, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, |
| pe Abony) ne Kala) ne Kala) ne Stanles) ne Stanles) ne Clevete) pe Sya Diego)  | * <u> </u>   |  |   |
| rtum<br>pre Kala)<br>pre Kala)<br>pre Stanles )<br>pre Chevter)<br>pre Syn Diego)  | : <u> </u>   |  |   |
| retion pe Kolo) pe Kolo) po Itenko) po Itenkolberg) po Cheeter)  | 200022<br>200022   | - 72 r 0 0 2 0<br>T 2 0 7<br>T 2 0 7   |   |
| ne Köln)<br>pe Stanles )<br>pe Teudelberg)<br>po Chester)<br>pe San Diego)   | ********<br>*********  | ۲۵ و و و و و و و و و و و و و و و و و و و   |   |
| pe Stanles)<br>po Heidelberg)<br>pe Chester)<br>po San Diego)  | <u> </u>   | ماروري.<br>د د و و م<br>د د و د<br>د د د   | 6,4,0,0<br>8,4,4,0,0<br>8,4,4,4,4,4,4,4,4,4,4,4,4,4,4,4,4,4,4,4                                 |
| po Rendelberg)<br>po Chester)<br>po San Diego)   | 2225   | 7 9 9 9 4<br>4 2 9 4<br>4  | 6, 1, 2, 3<br>6, 1, 2, 3  |
| ne Chester)  | 2222   | 2<br>2<br>2<br>3<br>3<br>3<br>3<br>3<br>3<br>3<br>3<br>3<br>3<br>3<br>3<br>3<br>3<br>3<br>3<br>3 | , 'u' 'o'   |
| pe San Diego)  | 255  | . 6.2.<br>. 6.2<br>. 6.2   | 0, n, Z <sub>11</sub>   |
|  |  | . 5, 6, 12<br>12, 12, 13   | -   |
| 1) 70 G 11033  | 7.   |  | d. a. n. 2.   |
| (Type Saint Paul)  |  |  | 1.2.3   |
| (Salmonella en (Tyne Zagrebi)  | 2  |  |   |
| (T) be Reading)  | IV. XII  |  | -   |
| (Salmonella ep (T) pe Kanosvar))   | IV. V. XII   | €  | 1 -   |
| (Type Kanpetad)  | IV. XII  | 4 6  |   |
| Typo Derby)  | 10. IV. XII  | -  |   |
| (T) pe Useen)  | <u>.</u>   |  | ,   |
| (Type Budapest)  | I. IV. XII   | i ti   | ş   |
| (T) pe California)   | 'n   | 1 in t   | 1   |
| Type Brandenburg)  | IV. XII  | , A  |   |
| (Type Bispebjerg)  | I. IV. XII   |  |   |
| Salmonella abortu ocquina  | IV. XII  | : 1  |   |
| Solmontlia sp (Type Arecharaleta)  | 5  | •  |   |
| 1118   |  | : ,  |   |
| Salmonella sp. (Type Altendorf)  |  | » e  |   |
| Salmonella sp. (Type Texas)  | ۲,   | <br>×  | e, n, z <sub>is</sub>   |
| I leignifies that this antigen may be absent. ( ) signifies  | s that only a part of this antigen i   | e present  |   |
| Salmonella op (Type Ar<br>Salmonella abortusoris<br>Salmonella op. (Type Ali<br>Salmonella op. (Type Te-   | <u>ਜ਼</u>  | <u>ਜ਼</u>  | IV, IVI, IV, IV, IV, IV, () signifies that only a part of t                                     |

Serological Types in the Genus Sa'monella—Antigenic Structure—Continued.

|       |        |   | mangenic Structure-Continued.              | inued.                     |                         |
|-------|--------|---|--|----------------------------|-------------------------|
| Group | No.    | - SACHE   | Somatic (O) Antigens                       | Flagellar (                | Flagellar (II) Antigens |
|       | 12     | Salmonolla abanda 1   |  | Phase 1                    | Phase 2                 |
| ħ'    | 18,    | Salmonetta aportusbons<br>Salmonetta sp. (Type Bredeney)                | (II), IV, XXVII, XII<br>I. IV. IXXVIII VII | ф.                         | e, n, x                 |
|       | ន      | Salmoncita sp. (1ype Schleussheim) Salmoncila sp. (Type Schwarzengrund) | IV, XXVII,                                 | 1, v<br>b, z <sub>11</sub> |                         |
|       | 5      | Solmonally 1: 10 100  | 1, 1V, AAVII, XII                          | р                          | 1,7                     |
|       | 8      | Salmonella choleraconia   | VI, VII, [Vi]                              | ,                          |                         |
|       | ដ      | Salmonella typhisuis  | VI, VII                                    | , :                        | 0 10                    |
|       | ,<br>E | Salmonella sp. (Type Thompson)  | VI, VII                                    | <u>0</u>                   | , r.                    |
| _     | 33     | Salmonella sp. (Typo Montevideo)  | V1, V1L                                    | K                          |                         |
|       | 3      |   | V 1, V II                                  | g, m, s                    | . 1                     |
| _     | 33     | Salmonella sp. (Type Virchew)   | V1, V11                                    | n, t                       | i                       |
| ,     | ဗ္ဗ (  |   | VI, VII                                    |                            | 103                     |
| 5     | 25     |   | V1, VII                                    | 63                         | 1                       |
|       | 3 6    | Salmonella sp. (Type Braenderup)  | VI, VII                                    | Ф                          | , i.i.                  |
|       | 3 5    |   | V1, V11                                    | е, р                       | אור פ                   |
|       | \$ =   | Salmonella sp. (Type Bareilly)  | V1, V11                                    | Ι, ν                       | 113 tr . 6              |
|       | ; 5    | Salmonella sp. (Type Hartford)  | VI. VII.                                   | ^                          | J. 5                    |
|       | 43     |   | VI. VII                                    | ۸                          | c, n, x                 |
|       | 41     |   | VI. VII                                    | ۲,                         | e, n, z <sub>is</sub>   |
|       | 43     | Salmonella sp. (Type Transity)  | VI, VII                                    | K Z Z                      | 1                       |
|       | 40     | Salmonella sp. (Type Generica)  | VI, VII                                    | ۰ <u>.</u> .               | 1, 2, 3                 |
|       | 47     | Salmonella 3p. (Type Panua)   | VI, VII                                    | 4 -5                       | 1, 5                    |
|       | ž č    | Salmonella sp. (Type Richmond)  | VI, VII                                    |                            | C, D, Z11               |
| į     | 3      | Salmonella sp. (Type Cardiff)   | VI, VII                                    | , h                        | 0, n, z <sub>11</sub>   |
|       |        | (washer that rough  | VI. VII                                    | -                          | 1, 10                   |

|        | នធូរ     | Salmonella sp (Type Puens) Salmonella sp (Type Puens)        | VI, VIII<br>VI, VIII                                       | , 9, 9, 9, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, |  |   |
|--------|----------|--|--|---|--|---|
| ,      | 8 5 5    | Salmonella sp. (Lype Nottbus) Salmonella sp. (Type Muenben)  | VI, VIII   | :<br>î a a  | 6 6 6<br>6 6<br>6 6<br>6 6<br>6 6<br>6 6 |   |
| ت<br>ت | <u> </u> | Salmonella ep (Type Manhattan)                               | VI, VIII   | ı च ,   | , 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, |   |
|        | 8        | Salmonella sp. (Type Litchfield)                             | VI, VIII   | »   | 1,2,3                                    |   |
|        | la 2     | Salmonella morbificans Solmonella en (Tyroc Narashina)       | VI, VIII   |   | z, n, x                                  |   |
|        | 8        | Solmandla ep (Type Buenos Aires)                             | VI, VIII   |   | e, n, x                                  |   |
|        | 8        |  | VI, VIII   | 210   | 6, n, Z,14                               |   |
|        | =        |  | VI, VIII   | 24, 224   | ı  |   |
|        | 8        |  |  | 11 <sub>2</sub> (1 <sub>2</sub>                   |  |   |
|        | B        |  | VI, VIII   | . ه   | e, n, x                                  |   |
|        | 5        | _  | (VIII)   | ۸٬,   | 7,0                                      |   |
|        | 3        | Salmonella ep (Type Virginia)                                | (VIII)   | 9   | ı  | - |
|        | 8        | Salmonella lunhosa   | IX, XII, IVI],   | P   | ı  |   |
|        | 6        | Salmonella enteritidis                                       | (I), IX, XII   | m is  | ı  |   |
|        | 3        | Salmonella vn. (Type Dublin)                                 | 1, IX, XII   | 6,5   | 1  |   |
| a      | S        | Salmonella ap (Type Rostock)                                 | 1, IX, XII   | g, p, u   | 1  |   |
|        | 9        | _  | IX, XII  | e ê   | ı  |   |
|        | <u>.</u> |  | IX, XII  | g, m, q   | l  |   |
|        | £;       | _  | IX, XII  | f, g, t   | 1  |   |
|        | 5        | _  | IX, XII  | 8, m, t   | ı  |   |
|        | =        |  | 1, IX, XII   | <u>بد</u>   | 1,5                                      |   |
|        | 13       | _  | [1], IX, XII   | 83  | 1,5                                      |   |
|        | 6.       | Salmonella sp (Type Mami)                                    | 13, 311  | 65  | 1,5                                      |   |
|        | :        | Salmonella sp. (Type Durban)                                 | IX, XII  | et.   | c, n, z,s                                |   |
|        | Š        | Salmonella sp. (Type Onarimon)                               | I, IX, XII   | م   | 1,2                                      |   |
| =      | rignifi. | pignifics that this antigen may be absent. ( ) signifies tha | ( ) signifies that only a part of this antigen is present. | present.  |  |   |

Serological Types in the Genus Salmonella—Anligenic Structure—Continued.

| Salmonella sp. (Type Leasthourne)   R. XII   Phase 1   Phase 1   Phase 2   |   |   |   |            |               | ı        |
|--|---|---|---|------------|---------------|----------|
| Right   Righ |   | Types                                   | Somatic (O) Antigens                    | Flagellar  | (II) Antigens |          |
| (a) (b) (c) (c) (c) (c) (c) (c) (c) (c) (c) (c   | 7 |   |   | Phase 1    | Phase 2       | ı        |
| (a) 1, 17, XXI   |   |   | In, IX, XII                             | -          | 12            | ı        |
| (a) (b) (c) (c) (c) (c) (c) (c) (c) (c) (c) (c   |   |   | Ľ                                       |            | -             |          |
| (a) (b) (c) (c) (c) (c) (c) (c) (c) (c) (c) (c   |   | Salmonella sp (Type Dar-es-Salaam)      | Ľ                                       | <u>-</u> - | ۰, ۲          |          |
| B), E, MI  |   | Salmonella sp. (Tyne Goottingen)        | 11, 21,                                 | ž.         | п'о<br>-      |          |
| I, I, X, XII   |   | Salmanella su (Tvns Isma)               | 17.47                                   | ١, ٧       | e, n, z,s     |          |
| H, N, XIII   |   | Solmonello collicario                   | (1), LA, XII                            | l, 23s     |               |          |
| K, XII   |   | Salmonella millamin                     | [1], IX, XII                            | 1          | . 1           |          |
| I, S, XII  |   | Solmonella en (Tress Cares II)          | IX, XII                                 | 1          | 1             |          |
| (1)   (1)   (2)   (3)   (4)   (4)   (4)   (5)   (4)  |   | Notwonerly on Chapte Canagrei           | IX, XII                                 | 27.9       | 1.5           |          |
| (b)   (c)   (c)  |   | Columnia of (Lype Italia)               | IX, XII                                 | ^          |               |          |
| (c) (c) (d) (d) (d) (d) (d) (d) (d) (d) (d) (d   |   | Salmonella sp. (Type Napoli)            | III. IX. XII                            |            | 11 1          |          |
| (c)  |   | Salmonella 3p. (Type Lonia Linda)       | II'X XI                                 | 1, 413     | т,<br>ц       |          |
| (a) (b) (c) (c) (c) (c) (c) (c) (c) (c) (c) (c   | _ | Salmonella sp. (Type New York)          | 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, | ದ .        | e, n, x       |          |
| II, X, XXVI  | 7 |   | Tr, WI                                  | ۲,         | 1,5           |          |
|  |   | Salmonella sp. (Type London)            | III, X, XXVI                            | ١. ٧       | - T           | <br>I    |
| (a) (b) (c) (c) (c) (c) (c) (c) (c) (c) (c) (c   |   | Saturdad ap. (Lype Cive)                | III, X, XXVI                            | -          |               |          |
| H, X, XXYI 6, b 1, 6 1, 6 1, 6 1, 6 1, 6 1, 6 1, 6   |   | Solution ap. (Lype Uganda)              | III, X, XXVI                            |            | , r           |          |
| H, X, XXYI   C, h   1, b   H, X, XXYI   C, h   1, 5   H, X, XXYI   C, h   1, 2, 3   H, X, XXYI   C, h   1, 2, 3   H, X, XXYI   C, h   1, 1, w   H, X, XXYI   C, h   1, 1, w   H, X, XXYI   C, h   H, X, XXYI   H, X, XXYI   H, X, XXYI   H, X, XXXYI   H, X, XXXXI   H, X, X, XXXI   H, X, XXXXI   H, X, X, XXXI   H, X, XXXXI   H, X, X, XXXI   H, X,   |   | מתווויייייייייייייייייייייייייייייייייי |   | 1 -        |               |          |
| s)   |   | Saimoneila sp. (Type Muenster)          | III X XXV                               | - °        | 2,6           |          |
| (a) (b) (c) (c) (c) (d) (d) (d) (d) (d) (d) (d) (d) (d) (d   |   | Salmonella sp. (Type Nyborg)            | 111 7 2241                              | e, n       | 1,5           |          |
| Type Meleagris   III, X, XXVI   6, h   1, 2, 3     Type Shingari)   III, X, XXVI   d   1, w     Type Shingari)   III, X, XXVI   d   1, 5     Type Amageri   III, X, XXVI   k   1, 5     Type Amageri   III, X, XXVI   x   x   x     Type Aleagreen   III, X, XXVI   x   x     Type Meltayreden   III, X, XXVI   x     Type Meltayreden   x   x     Type Meltayreden   x   x     Type Meltayreden   x     T |   | Salmonella sp. (Type Veile)             | 111 X 30111                             | e, p       | 1,7           |          |
| Cype Shangari  |   | Salmonella sp. (Type Melagaris)         | 111, A, XXVI                            | e, h       | 1, 2, 3       |          |
| Type Zanriban   11, 5, XXVI   d   1, 5     Type Zanriban   11, 5, XXVI   k   1, 5     Type Amager   11, 5, XXVI   y   1, 2, 3     Type Veltoyreden   11, 5, XXVI   z   1, 2, 3     Type Veltoyreden   1, 5     Type Veltoyreden  |   | Salmonella sp. (Tyna Shangari)          | III, X, XXVI                            | e, h       | , M           | <b>.</b> |
| (C) to American (C) (C) to American (C) (C) to American (C) (C) to Localization (C)  |   |   | III, X, XXVI                            |            | : w           |          |
| (Type Levinger)  III, X, XXVI  (Type Levinger)  III, X, XXVI  (Type Nettoyreden)  III  |   |   | III, X, XXVI                            |            | - i           |          |
| (Type Weltevreden)   |   | Salmonella an. (Type Loringer)          | III, X, XXVI                            | ٤ ۽        | 1,0           |          |
|  |   | Salmonella sp. (Type Weltevreden)       | III, X, XXVI                            | 01Z        | 111           |          |

|    | 101      | Salmonella in Type Ontan  | III, X, XXVI   | `       | 1,5         |
|----|----------|---|--|---------|-------------|
|    | 103      | Salmonella en (Tvne Butantan)                                     | III, X, XXVI   | ۵       | 1, 5        |
|    | Š        |   | III. XV  | 9.0     | 1,6         |
| p  | 1 5      |   | III. NV  |         | 1.7         |
| ĭ  | 3        | Colmonally on (Time Note Retenuish)                               | VX.TI  | 2       | 7.1         |
|    | 5 5      |   | TILL CAN'T WALLET  |         |             |
|    | 3        | Salmonella sp (1 ypo Illinois)                                    | (111), (27), 22217   | 210     | 1,0         |
|    | 130      | Salmanella sp. (Type Senftenberg)                                 | I, III, XIX  | g. 8. t | 1           |
|    | =        | Salmonella an (Type Nilocse)                                      | 1, 111, XIX  |         | *2          |
| ធី | 22       |   | I, III, XIX  | .52     | -           |
|    | 23       | Salmonella ap (Type Taksony)                                      | 1, 111, XIX  | -       | <b>\$</b> z |
|    | E        | Salmonella ap (Type Kentucky)                                     | XX,  | -       | 24          |
|    | 115      | Salmonella ap (Type Aberdeen)                                     |  | -       | 1, 2, 3     |
|    | 110      | Salmonella sp (Typo Rubislaw)                                     |  |         | 6. D. X     |
|    | 11       | ~   |  |         | 23          |
|    | 118      | _   |  |         | , ,         |
|    | 12       |   |  |         |             |
|    | 2        | _   |  |         |             |
|    | 121      | -   |  |         | 2, 11, 2, 2 |
| p. | 2        | : 5   |  |         | 2 -         |
|    | 23       | -   | XXII   | ; -     |             |
|    | 2        | _   | XXII   | : .     |             |
|    | 55       | _   | HXX  |         |             |
|    | 130      |   | I. XXIII   |         | , ac        |
|    | 23       |   | L. XXIII   | . ~     | . 1         |
|    | 25       | Salmonella ep. (Type Havana)                                      | I. XXIII   |         | į           |
|    | 2        | Salmonella sp (Type Worthington)                                  | LXXIII   |         |             |
|    | 8        | _   | LXXIII   |         | . 1         |
|    | 13       | Salmonella up (Typo Heves)  | · rv, xxiv   |         | 1,5         |
| Ξ  | aignifie | ( ) signifies that this antigen may be absent. ( ) signifies than | ( ) eiguifies that only a part of this anticon is oresent. | resent. |             |

Serological Types in the Genus Salmonella-Antigentic Structure-Concluded.

| Louin | No. | <b></b>                            | Sometic (O) Anguent | Tagellar (   | Pagellar (H) Antigens |
|-------|-----|------------------------------------|---------------------|--------------|-----------------------|
|       |     |                                    |                     | Phase 1      | Phase 2               |
| _     | 132 | Salmonella sp (Type Carrau)        | VI, XIV, XXIV       | A            | 1,7                   |
|       | 133 | Salmonella sp (Type Onderstepoort) | (D, VI, XIV, XXV    | e, (h)       | 1,5                   |
|       | 134 | Salmonella sp (Typo Florida)       | (I), VI, XIV, XXV   | . P          | 1,7                   |
|       | 135 | Salmonella sp (Type Madelta)       | (I), VI, XIV, XXV   | 'n           | 1,7                   |
|       | 136 | Salmonella sp. (Type Sundsvall)    | (I), VI, XIV, XXV   | N            | 0, n, x               |
|       | 137 | Salmonella sp. (Type Orient)       | XVI                 | *            | 0, n, z <sub>15</sub> |
| _     | 138 | Salmonella sp. (Type Hvittingfoss) | IAX                 | م            | 6. n. x               |
|       | 139 | (Type                              | XVI                 | 70           | 1,7                   |
| Œ     | 140 |                                    | XVZ                 | 24           |                       |
|       | 141 |                                    | . XVII              | ۵            | 12                    |
|       | 173 | Salmonella sp. (Type Cerro)        | · XVIII             | Z4. Z35. Z31 | : 1                   |
|       | 25  | Salmonella sp. (Type Minnesota)    | XXI. XXVI           | P .          | , n                   |
|       | #1  | Salmonella sp. (Type Tel Aviv)     | XXXIII              | >            |                       |
|       | 145 |                                    | XXVIII              | , >          | 1.7                   |
|       | 146 | Type                               | XXXX, (Vi)          | , N          | 1                     |
|       | 141 | Salmonella sp. (Type Hormaeche)    | XXXX, IVII          | Z.0. [Z.1]   | 1                     |
|       | 118 | Type                               | XXX                 | P 4          | 5                     |
|       | 143 | Salmonella sp. (Type Adelaide)     | XXXX                | -            | :                     |
|       | 3   | Salmonella sp. (Type Inverness)    | XXXVIII             |              | -                     |
|       | 151 | Salmonella sp. (Type Champaign)    | XXXX                | 1 24         | - F                   |

( ) signifies that only a part of this antigen is present. I Isignifies that this antigen may be absent.

1. Salmonella paratyphi (Kayser) Castellani and Chalmers. (Bacterium paratuphi Typus A. Brion and Kayser, Munch med. Wchaschr., 49, 1902, 611, Bacterium paratyphi Kayser, Cent f. Bakt., I Abt., Ong., 31, 1902, 426; Bacillus paratuphosus A Boycott, Jour Hyg , 6, 1906, 33; Bacillus paratyphs Winslow and Kligler, Jour. Bact, 1, 1916, 81, Bacillus paratuphasus Winslow, Kligler and Rothberg, Jour. Bact., 4, 1919, 474; Salmonella paratuphs and Solmonella paratuphs A Castellam and Chalmers, Man Trop Med , 3rd ed., 1919, 938 and 939, Bacterium paratuphosum A Holland, Jour Bact , 5, 1920. 219 ) From Latin para, like and typhus, typhoid.

Rods 06 by 30 to 40 microns, occurring singly. Motile with peritrichous flagella Gram-negative

Gelatin colonies Bluish-gray, homogeneous, smooth, glistening, entire to slightly undulate

Gelatin stab. Fair surface growth No

liquefaction
Agar colonies. Grayish, homogeneous, smooth, glistening, entire to slightly

undulate
Agar slant. Filiform, grayish, smooth, glistening growth.

Broth Turbid, with slight graysh sediment.

Litmus milk ! Slightly acid

l'otato. Limited, dirty-wlute streak Indole not formed

Nitrites produced from nitrates Acid and gas from glucose, fructose,

Acid and gas from glucose, fructose, glactose, mannose, arabinose, maltose, trehalose, dettrin, glycerol, mannitol, duleitol, rhamnose and sorbitol. No acid or gas from lactose, sucrose, raffinose, xylose, saliem, inulin, adonitol or mositol

Reduces trimethylamine oxide (Wood and Baird, Jour Fish, Res. Bd Canada, c. 1913, 198).

No hydrogen sulfide formed Acrobic, facultative. Optimum temperature 37°C.

Source: Isolated from enteric fever in man. Not known to be a natural pathogen of animals.

Habitat: A natural pathogen of man causing enteric fever.

2. Salmonella schottmuelleri (Winslow et al.) Bergey et al (Bacilli paratyphique, Achard and Bensaude, Soc. Méd. des Hôp. de Paris, 13, 1896, 679; Bacillus paratyphi alcaligenes Schottmüller, Deutsche med, Wchnschr., 52, 1900, 511; Bacterium paratuphi Typus B. Brion and Kayser, Münch, med. Wehnschr , 49, 1902, 611, Bacillus paratyphosus B Boycott, Jour. Hyg , 6, 1905, 33, Bactersum paratuphosum B Le Blaye and Guggenheim, Manuel Pratique de Diag. Bact., 1914; Bacillus schallmillers Winslow, Kligler and Rothberg, Jour. Bact . 4, 1919, 479, Salmonella paratuphi B Castellant and Chaimers, Man Trop. Med , 3rd cd , 1919, 939, Bacterium schottmullers Holland, Jour Bact., 5, 1920, 222; included in Group IV of Hecht-Johansen, Copenhagen, 1923; Bargey et sl , Manual, 1st ed., 1923, 213.) Named for Prof. Schottmüller who isolated this organism in 1899.

Rods. 0 6 to 0 7 by 2 0 to 3 0 mlcrons, occurring singly and in pairs. Motile with peritrichous flagella. Gram-negative

Gelatin stab. No hquelaction.

Agar colonies Small, circular, bluishgray, transparent, homogeneous, entire to undulate.

Broth Turbid with thin gray pelhele and sediment. Fecal odor

Litmus milk. Slightly acid, becoming

Potato Grayish-white, viscous growth

Indole not formed

Nitrates produced from nitrates
Acid and gas from glucose, fructose,

galactore, mannose, arabinore, xylose, maltore, dextrin, trehalose, glycerol, mannitol, dulcitol, sorbitol, rhamnose and inositol. No acid or gas from Inctose, sucrose, inulin, salicin or adonitol and usually not from raffinose,

Reduces trimethylamine oxide (Wood and Baird, loc. cil.).

Hydrogen sulfide produced.

Optimum temperature 37°C.

Acrobic, facultative.

Antigenic structure: [I], IV, [V], XII: b: [1,2].... Some strains lack antigen V and some have I.

Source: Isolated from eases of enteric fever in man. Not a natural pathogen of animals.

Habitat: A natural pathogen of man causing enteric fever. Also found rarely in cattle, sheep, swinc, lower primates and chickens.

 Salmonella sp. (Type Abony). (Salmonella abony Kauffmann, Acta Path. et Microbiol. Scand., 17, 1910, 1.)

Antigenie structure · [I], IV, V, XII: b e, n, v.

Source: Isolated by Kaufmann from a mixed culture of Salmonella abortus boris sont to him by Dr. K. Rauss, Budapest. Later three additional cultures were received from Dr. Rauss Original culture from the feeces of a normal person.

Habitat: All cultures thus far recognized have been from human sources.

 Salmoneila typhimurium (Loeffler) Castellani and Chalmers. (Bacillus typhimurum Loeffler, Cent. f. Bakt. 11, 1802, 192; Bacterium typhimurum Chester, Ann Rept Del Col. Agr Exp. Sta., 9, 1897, 70; Bacillus murium Miguls, Syst. d. Bakt. 2, 1900, 761; Castellani and Chalmers, Man Trop. Med., 3rd ed., 1919, 933; Bacillus typhi-murium Holland, Jour. Bact., 5, 1920, 221; Bacterium typhi-murium Holland, identification typhimurium; Bacillus enteritidis B, Typ. murium Januschke, Zischr. f. Infektionskr. d. Haustiere, 27, 1924, 1823.

The following are regarded as synonyms of this organism. Salmonella

psittacosis Castellani and Chalmers (Man. Trop. Med , 3rd ed., 1919, 939, Bacillus psittacosis Nocard, Conseil d. Hyg. Publique et Salubrité du Dept du Seine, Séance, March 24, 1893; Bacterium psittacosis Le Blaye and Guggenheim, Manuel Pratique de Diagnostic · Bactériologique, 1914); Salmonella gertrycke Castellani and Chalmers (Man Trop. Med., 3rd cd., 1919, 939; Bacillus aertrycke De Nobele, Ann Soc Méd Gand., 72, 1898, 281; Bacillus paraaertrycke Castellani, Ann. di Med Nav e Colon., 11, 1914, 453; Bacterium acrtrycle Weldin and Levine, Abst. Bact, 7, 1923, 13); Kaensche's Bacillus and Basenau's Bacillus, Kaensche, Zischt. f. Hyg., 22, 1896, 53; Bacillus pestiscariae Wherry (Jour. Inf. Dis , 5, 1908, 519; Bacillus cholera-caviae Wherry, Pub. Health Repts., November, 1908, Pasturella pestis-caviac Holland, Jour. Baet., 5, 1920, 219); Bacillus paralyphosus B, Mutton type, Schutze, Lancet, 1, 1920, 93; Group VII of Hecht Johansen, Copenhagen, 1923; Salmonella aerirycke Ibrahim and Schütze, Brit. Jour. Exp Path., 9, 1928, 353; Bacterium entertidis Breslau and Salmonella breslau of German literature; Mouse-typhoid of many Some strains are confused with nuthors Salmonella anatis because of their origin in ducklings, e.g., see Salmonella ana. tum var. aertrycke Olsen and Goetchins, Cornell Vet , 27, 1937, 354

Hauduroy et al. (Diet d. Bact. Path. Paris, 1937, 449) regard the follosing as symonyms of Salmonella actryck: Bacultus breslaviensis Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., et 1895, 371. Bacterium breslaviensis Chester, Ann Rept. Del. Col. Agr. Exp. Sta., 9, 1907, 69; B. entertidis breslaviense Berge, Deut. Derzett Wehnsehr, 1906, 473. Salmonella meleogridus Rettger, Plastidge and Cameron, Jour. Int. Dis. 53, 1933, 279; Salmonella actrycle var. meleogridis Cameron and Rettger, Jour. Bact., 27, 1934, 85.

See Edwards and Bruner, Kentucky

Agr. Exp. Sta. Bull. 400, 1940, 43-70, for a discussion of this species.

Rods: 0 5 by 1.0 to 1.5 microns, occurring singly Motile with peritrichous flagella. Gram-negative

Gelatin colonies: Small, circular, gray-1sh, granular, becoming yellowish-brown.

Gelatin stab: Flat surface growth. No liquefaction

Agar colonies: Small, circular, grayish, entire to undulate.

Agar slant: Filiform, grayish, moist, entire growth

Broth: Turbid.

Litnius milk: Slightly acid, becoming alkaline.

Potato: Grayish-white streak

Indole not formed.

Nitrites produced from nitrates. Acid and gas from glucose, fructose, galactose, arabinose, maltose, destrin, mannitol, sorbitol and inositol Acid from glycerol. No action on lactose, sucrose, raffinose, Inulin, salicin or

adonitol.

Reduces trimethylamine oxide (Wood and Baird, loc. cit ).

Hydrogen sulfide produced

Optimum temperature 37°C. Aerobie, facultative.

Antigenic structure [1], IV, [V], Xff:

Source: Isolated during a mouse typhoid epidemic in the Hygienic Institute of Greifswald, Germany.

Habitat: Causes food-poisoning in man A natural pathogen for all warmblooded animals. This type occurs more frequently than any other type not confined to a specific host. Also found in gnakes by Hinshaw and McNeil (Amer. Jour. Vet. Res., 6, 1915, 201).

4a. Salmonella tuphirurium (Type Binns). (Bacillus paratypheus B Bans type, Sel ütze, Lancet, I, 1920, 93, Group VI of Hecht-Johnsen, Copenhysen, 1923; Typus-llinns, Kauffmann, Zhl. d. grs Hr., 25, 1931, 273; Salmonella typhirurium art. Copenhysen, Kauffmann, Ztsebr. I. Hyg., 116, 1934, 368; Salmonella typhi-murium var. Binns, Schütze et al., Jour. Hyg., 34, 1934, 339; Salmonella aertrycke var. Storrs, Edwards, Jour. Baet., 50, 1935, 471.)

Morphology and cultural characters indistinguisbable from those of Salmonella typhimurium, except some strains ferment maltose late or are anacrogenie.

Antigenic structure: [II, IV, XII; i-1, 2, 3 ... (Edwards, Jour. Hyg. 56, 1936, 348) Many colonies may be examined before the specific phase flagellar antigen is demonstrated. Differs from Salmonella typhimurum in lacking antigen V.

Source: Isolated by Dr. McNee from a case of food poisoning in man, France, 1919.

Habitat: Natural host the pigeon, and may infect other animals, including man.

Salmonelia sp. (Type Köln). (Salmonella töln Sievers, Cent. f. Bakt., I Abt., Orig., 150, 1943, 52; Salmonella coeln Kaufimann, Acta Path. et Microbiol. Scand, Suppl. 51, 1914, 33)

Antigenic structure: IV, V, XII: y;

1, 2, 3 . . .

Source: A single culture isolated from a human case of enteritis.

Habitat. Not reported from other sources as yet.

6. Salmonella sp. (Type Stanley). (Bacillus paralyphosus B, Stanley) type, Sel lutre, Lawcet, I, 1920, 93; Salmonella stanley i Haupt, Ergebnisse d. Hyg, 18, 1932, 673, Salmonella Stanley type, White, Med. Res. Council, Spec. Rept. Ser. 103, 1920, 19; Salmonella stanley Warren and Scott, Jour. Hyg, 29, 1929, 415; Typus Stanley, Kaulimann, Zischr. Hyg., 111, 1930, 210)

Antigenie structure: IV, V, XII: d:

Source: Isolated from cases of human food poisoning in Stanley, England by Hutchens (1917).

Habitat: Not known as a natural pathogen of animals.

Salmonella sp. (Type Heidelberg). (Bacterium enteritidis, Typus Heidelberg, Habs, Cent. f. Bakt., I Abt., Orig., 150, 1933, 367; Salmonella beidelbera Sebutze et al., Jour. Hyg., \$4, 1934, 340.) Antigenic structure: IV, V, XII: r:

Source · Isolated from cases of human food poisoning in Heidelberg, Germany. Habitat: Not known as a natural

pathogen of animals

8. Salmonella sp. (Type Chester). (Salmonella chester Kauffmann and Tesdal, Ztschr. f. Hyg., 120, 1937, 168.)

Antigenie structure: IV, [V], XII; e.

h: e, n, x . . .

Source. Isolated by W. H. Grace, Chester, England, from gastroenteritis in man. Typed by Kauffmann and Tesdal (loc. cit.).

Habitat: Has usually been found in human feces.

9. Salmonella sp. (Type San Diego). (Salmonella san diego Kauffmann, Actn Path. et Microbiol Scand , 17, 1940, 429 ) Antigenie structure. IV, [V], XII: e, h e, n, z<sub>11</sub> . .

Source: Originally isolated from cultures sent to Dr. Kauffmann by Dr. K. F. Meyer who obtained them from nn outbreak of food poisoning near San Diego, California Also reported from Den-mark, Uruguay and Kentucky.

Habitat Usually has been isolated from human feces, but has been found in birds and other animals.

10 Salmonella sp. (Type Salmas). (Salmonella salinatis Edwards and Bruner, Jour Bact , 44, 1942, 289.)

Antigenic structure: IV, XII: d, e, h:

d, e, n, z15 . .

By cultivation in semi-solid agar containing agglutinating serum for Salmonella typhosa, an organism having the antigenic formula for Salmonella sp (Type San Diego) was isolated

Source: From rat feces collected by Dr. Henry Welch near Salinas, California.

Habitat: Also found in normal human carriers.

 Salmonella sp. (Type Saint Paul). (Salmonella saint paul Edwards and Bruner, Jour. Inf. Dis., 66, 1940, 220)

Antigenic structure: 1, IV, V, XII: e,

h: 1, 2, 3 . . .

Source: A single culture isolated from the liver of a turkey poult by Dr. B. S. Pomeroy, St. Paul, Minnesota, Two cases in man.

Habitat: Also reported from hogs

11a. Salmonella sp. (Type Zagreh) (Salmonella 2agreb Kauffmann, Acta Path. et Microbiol. Scand., 17, 1949, 351.)

Antigenic structure: IV, V, XII.e, h. 1. 2 . . . This is a minor type of No 11. Source: Culture received by Dr. Kauffmann under the label S. reading

from Dr. N. Cernozubov of Zagreb, Jugoslavia.

Habitat: Not reported from other sources as yet.

12. Salmonella sp. (Type Reading) (Bacillus paratyphosus B, Reading type,

Salmonella readingensis Haupt, Ergebnisse d. Hyg., 15, 1932, 673.)

Antigenic structure: IV, XII: c, h: 1.5 ...

Source: Isolated from the Reading, To dond meter groundy by Dr H Schütze.

Habitat: A cause of gastroenternis in man.

12a. Salmönella sp. (Type Kaposvar). (Salmönella kapostar Rauss, Cent f Bakt., I Abt., Orig, 147, 1911, 253; also see Kauffmann, Die Bakteriologie der Salmönella-Gruppe, Kopenhagen, 1941, 212)

Antigenic structure: IV, V, XII: e, (h) I, 5.... This is a minor type of

Source: From the feees of three mem-

pers of a family suffering from gastroenteritis.

Habitat: Not reported from other

sources as yet.

13 Salmonella sp. (Type Kaapstad). (Salmonella reading var. kaapstad Henning, Rhodes and Gordon-Johnstone, Onderstepoort Jour. Vet. Sci. Animal Ind., 16, 1941, 103, Salmonella kaapstad Kaufmann, Acts. Path. et Microbol Scand., 19, 1942, 523.)

Antigenic structure: IV, XIf. e, h.

Source, From a child with meningitis. Habitat: Not known from other sources as yet

14 Salmonella sp. (Type Derby) (Bacillus entertidis Peckham, Jour. Hg. 22, 1923, 69, Derby type, Savage and White, Med Res Council Spec Rept Ser. 91, 1925, 19; Salmonella derby War-

Antigenic structure [I], IV, XII:

Source, Isolated from tank water at Derby, England

Habitat. Widely distributed. Found in human feces, lymph glands of hogs, chickens, etc.

15 Salmenella sp. (Type Essen) (Salmenella essen 173 Hohn and Herrmann, Cent. f. Bakt., I Abt., Orig., 135, 1936, 505)

Antigenie structure: IV, X11: g, m -.

Source: Isolated from the feces of an infant, Essen, Germany.

Habitat. Known only from human sources.

Salmonella sp. (Type Budapest).
 (Salmonella budapest Rauss, Ztschr. f.
 Immunitätsf., 95, 1929, 489.)

Antigenic structure: I, IV, XII: g,

Source: Originally isolated in Budapest from 3 normal persons and from 3 persons with enteric fever,

Habitat: Known only from human sources

Salmonella sp. (Type California).
 (Salmonella catifornia Edwards, Bruner and Hinshaw, Jour. Inf Dis. 68, 1910, 127; Hinshaw, Hilgardia, 15, 1941, 583.)
 Antigenie structure IV, XII. g. m.

-,

Source, Srx cultures isolated from infeeted turkey poults from Cahfornia. The seventh culture was isolated from a turkey in a second outbreak of the Infection Reported by Pomeroy and Fenstermacher (Jour. Amer. Yet. Med. Assoc. 94, 1936, 90). Also found in hogs and man (Cdwards and Bruner, Jour. Inf Dis. 72, 1913, 64).

Habitat, Also reported from chickens and ducks. Widely distributed

Salmonella sp. (Type Branden-burg). Kugfi-mann and Matum, Zuehr. f. Hyg., 111, 1930, 740, Kauffmann, Zenthl. f. d ges Ilyg., 123, 1931, 273, Salmonella branden-burgensu Haupt, Ergchnisse d Ilyg., 13, 1972., 673, Salmonella branden-burgensu Haupt, Ergchnisse d Ilyg., 13, 1972., 673, Salmonella branden-burgensu Schütte et al., Jour., Ilyg., 34, 1931, 510)
 Antigene structure: IV, XNI: 1, vy.

e, n, z<sub>14</sub>. . . See Kauffmann, Ztschr. f. Hyg., 118, 1936, 510.

Source, Isolated from a case of gastroenteritis at the Virehow Hospital of Berlin. Habitat: Known only from human sources.

19. Salmonella sp. (Type Bispebjerg). (Salmonella bispebjerg Typus, Kauffmann, Ztschr. f. Hyg., 118, 1936, 540.)

Antigenic structure: 1, IV, XII: a: e, n, x. . . .

Source: Isolated from a case of gastroenteritis at the Bispebjerg Hospital in Copenhagen.

Habitat: Not reported from other sources as yet.

20. Salmonella abortivoequina (Good and Corbett) Bergey et al. (Bacillus abortirus equinus Good and Corbett, Jour. Inf. Dis., 13, 1913, 53; Bacillus abortus equi Meyor and Boerner, Jour. Med. Res., 29, 1913, 330; Bacillus abortivo-equinus Good and Corbett, Jour. Inf. Dis., 18, 1916, 556; Bacıllus abortus equinus Weiss and Rice, Jour. Med. Res., 35, 1907, 403; Bacillus abortivus Winslow, Kligler and Rothberg, Jour. Bact., 4, 1919, 177; Bacıllus abortus-equi Holland, Jour. Bact., 5, 1929, 216; Bacterium abortum-equi Holland, ibid.; Bergey et al , Manual, 1st ed., 1923, 217; Bacillus enteritidis B, Typ equinus Januschke, Ztschr. f. Infektionskr. d. Haustiere, 29, 1924, 182, Salmonella abortus-eque Bergey et al., Manual, 2nd ed., 1925, 236.) From Latin, aborting and equine.

Antigenic structure. IV, XII. -: e, n. x. . .

Reduces trimethylamine oude (Wood and Baird, loc. cit.).

Source: Isolated from afterbirth of mares that had aborted

Habitat. A natural pathogen of mares, causing abortion. Infectious for guinea pigs, rabbits, goats, cows, producing abortion

 Salmonella sp. (Type Arechavaleta). (Salmonella arechavaleta Hormaeche and Peluffo, quoted from Hormaeche et al., Jour. Bact., 47, 1944, 323) Named in honor of Prof. Arechavalets of Uruguay,

Antigenic structure: IV, [V], XII: s:

1, 7. . . .

Source: From a human case of gastroenteritis. Also found by Dr. P. R. Edwards among cultures sent to him from the Canal Zone for identification.

Habitat: Known only from human sources.

22. Salmonella abortusoris (Lovell)
Sobrius ovis Schermer and Etnich, Cen.
f. Bakt., I Abt., Ref., 75, 1922, 232, Zecillus enteritidis C, Typ., ovis Januschis,
21sch. I. Infektionskr. d. Haustler, 8;
1924, 182; Bacterium abortus ovis Lovell,
Jour. Path. and Bact., 54, 1931, 13;
Typus-Abortus ovis, Kauffmann, ZeilBbl. f. d. ges. Hyg., 25, 1931, 273, Schütz
et al., Jour. Hyg., 54, 1934, 490)

Antigenic structure: IV, XII: c: !, 6. . . .

Reduces trimethylamine oxide (Wood and Baird, loc. cil.).

Source: Isolated from cases of abortion in sheep.

Habitat: Not known to infect any other animal.

23. Salmonella sp. (Type Altendorf). [Salmonella altendorf Hohn, Cent. f. Bakt., I Abt., Orig , 146, 1940, 218]

Antigenic structure: IV, XII: c: 1,

Source: Isolated from a case of scute gastroenteritis from Altendorf, Germany.

Habitat: Not reported from other sources as yet.

24 Salmonella sp. (Type Texas) (Salmonella texas Watt, De Capito and Moran, U. S. Public Health Repts., 62,

1917, 808.)
Antigenie structure: IV, V, XII: k:e,

n, z<sub>15</sub>.... Source: Isolated by Dr. James Watt from the feces of a boy convalescing from diarrhoca.

Habitat Not reported from other sources as yet.

25. Salmonella abortusbovis Kauffmann. (Kausimann, Ztschr. f. Hyg., 120, 1937, 194)

Antigenic structure; [1], IV, XXVII, XII: b: c. n. x. . . .

Liquefics gelatin (Kauffmann, Ztschr.

f Hyg., 117, 1936, 778). Source: Isolated and incompletely typed by H Bernard, Ztachr, f. Hyg.,

117, 1935, 352. Habitat: Normally found in cattle, causing abortion Occasionally occurs in man.

26 Salmonella sp. (Type Bredeney) (Salmonella bredenen Kauffmann, Zischr f Hyg., 119, 1937, 356.)

Antigenic structure, I, IV, [XXVII], XII. l. v: 1, 7. . . .

Source. Found by Hohn and Herrmann in Bredeney, Cermany, Typed by Kauffmann (loc cit.). From cases of human gastroenteritis and an abseess of lower jaw.

Habitat · Isolated from human sources Also found in normal hogs and chickens 27 Salmonella sp. (Type Schleiss-

heim). (Salmonella schleissheim Kauffmann and Tesdal, Ztschr. f. Hyg., 129, 1937, 171 ) Antigenic structure IV, XXVII, XII

b, z<sub>n</sub> -.

Liquefics gelatin (Kauffmann aml Tesdal, loc cit).

Source, Isolated by Hopfengariner (Münchener tierarz, Wehnschr., 1, 1929, 185) in Schleissheim, From cattle Typed by Kauffmann and Tesdal (loc. cit) Also found by Tillmanns in the liver of a horse (Ztschr f. Fleisch, u Milch Hyg., 50, 1910, 100). Caused an outbreak of gastroenteritis in 30 persons (Kanfimann, Acta Path. et Microbiol Scand , 17, 1910, 1).

Habitat: Apparently widely dis tributed.

28. Salmonella sp. (Type Schwarzen-

grund), (Salmonella schwarzengrund Kauffmann, Acta Path. et Microbiol. Scand., Suppl. 44, 1914, 31.)

Antigenic structure: I. IV. XXVII. XII: d: 1. 7.

Source: A single culture isolated by Dr. J. Hohn from a human case of enteritis that occurred in Schwarzengrund. ncar Breslau, Germany.

Habitat: Not reported from other sources as yet.

29. Salmonella hirschieldii Weldin. (Bacillus paratyphosus & Weil, Wien. klin. Wchnschr., 30, 1917, 1061; Bacillus erzinjan Neukirch, Ztschr. f. Hyg , 85, 1918, 103; Paratyphoid C bacillus, . Hirschfeld, Lancet, 1, 1919, 296; "Para-C", Mackie and Bowen, Jour. Roy. Army Med. Corps, \$3, 1919, 154; Bacillus paratyphosus C Andrewes and Neave. Brit. Jour. Exp. Path., 2, 1921, 157; Paratyphus N1, Iwaschenzoff, Arch. f. Schiffs-u. Trop. Hyg , \$0,1926,1; Weldin, Iona Sta. Coll. Jour. Sci., 1, 1927, 161; Bactersum hirechfeldit Weldin, ibid., 161; Typus-Orient, Kauffmann, Zbl. f. d. ges 113g, 25, 1931, 273; Salmonella paratuphi C Castellani and Chalmers. Man. Trop. Med., 3rd ed., 1919, 939; Salmonella paratyphozus C Castellani and Chalmers, ibid., 952.) Named for Hirschfeld who worked with this organism

Rods: 0.3 to 0.5 by 1.0 to 2.5 microns, occurring singly. Motile with peritrichous flagella Gram-negative.

Gelatin colonies: Grayish, smooth,

flat, glistening, margin irregular. Gelatin stab: Flat, grayish surface

growth. No liquefaction. Agar colonies: Grayish, moist, smooth,

translucent Broth: Turbid.

Litmus milk: Slightly soid, becoming alkaline. Indole not formed

Nitrites produced from nitrates. Acid and gas from glucose, fructose,

maltose, arabinose, xylose, dextrin, trebalose, mannitol, dulcitol and sorbitel. No action on lactore, sucrose, salicin, adonitol or inositol. Rarely may fail to form gas from sugars (Nabih, Jour. Hyg., 41, 1941, 39).

Reduces trimethylamine oxide (Wood

and Baird, loc. cit.). Hydrogen sulfide produced.

Optimum temperature 37°C.

Aerobie, facultative.

Antigenie structure: VI, VII, [Vi]: c: 1, 5. . . .

Source: Isolated from cases of enteric fever in man. Habitat: A natural pathogen of man

causing enteric fever. Salmonella choleraesuis (Smith) Weldin. (Probably not the Bocillus of swine plague, Klein, Report of the Medical Officer of the Local Gov. Bd., England, 1877-78, Supplement, p. 168; Bocterium of swine plague, Salmon, U. S. Dept. Agr. Bur. An. Ind. Ann. Rep., 1885, 212; Bactersum of hog cholera. Salmon, 1bid., 1886, 20; Bakterium der Schweinepest, Selander, Cent. f. Bakt., 5, 1888, 361; Posteurello solmoni Trevisan, I generi e le specie delle Batteriacee, 1889, 21; Bocterium cholerge suis Th. Smith, U. S. Dept. Agr Bur. An. Ind., Bull. 6, 1894, 9, Swine-feverbacillus, Klein, Cent. f. Bakt., I Abt , 18, 1895, 105; Bocillus suipestifer Kruse, in Flogge, Die Mikroorganismen, 3 Aufl., 2. 1896, 401; Bacterium cholerae suum Lehmann and Neumann, Bakt. Diag, I Aufl , 2, 1896, 233; Bacterium suipestifer Chester, Ann. Rept. Del. Col. Agr. Exp Sta , 9, 1897, 70; Bacillus cholerae suum Migula, Syst d. Bakt., 2, 1900, 759; Le microbe du hog-cholera, Lignières, Bull Soc. Cent Méd. Vet., see Rec. de méd. vét., Paris, Sér 8, 7, 1900, 389; Bacıllus salmon: Chester, Manual Determ Bact , 1901, 210; Bacterium intestinale surs Le Blaye and Guggenheim, Manuel Pratique de Diagnostic Bacteriologique, 1914, Bacıllus surs Krumwiede, Kohn and Valentine, Jour. Med. Res., 38, 1918, 89, Bacterium (Salmonella) cholera surs Buchanan,

Jour. Bact , S. 1918, 53; Salmonella

suipeslifer Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 939; Bacillus cholerae-suis Winslow, Kligler and Rothberg, Jour. Bact., 4, 1919, 476, Bacterium cholerae-suis Holland, Jour Baet., 5, 1920, 217; Bacillus paratupho. sus B (Arkansas type), Schütze, Lancet, 2, 1920, 93; included in Group I suipestifer, Andrewes and Neave, Brit Jour. Exp. Path., 2, 1921, 157; Weldin, Iowa Sta. Coll. Jour. Sci., 1, 1927, 155; Typus suipestifer Amerika, Kauffmann, Zbl f. d. ges. Hyg., 25, 1931, 273, the American Salmonella suspestifer of many authors) From Latin, hog cholers.

Solmonello choleraesuis (Smith) Weldin is the type species of the genus Solmonella.

Rods: 0.6 to 0.7 by 2.0 to 30 microns, occurring singly. Motile with four to five peritrichous flagella. Gram-negative.

Gelatin colonies: Grayish, smooth, flat, glistening; margin irregular.

Gelatin stab: Flat, grayish surface growth. No liquefaction. Agar colonies: Grayish, moist, smooth,

translucent. Agar slant: Grayish, moist, smooth,

translucent growth. Broth: Turbid, with thin pellicle and

grayish-white sediment. Litmus milk: Slightly acid, becoming

alkaline, opalescent, translucent to yellowish-gray. Potato: Grayish-white streak becom-

ing brownish.

Indole not formed.

Nitrites produced from nitrates Acid and gas from glucose, fructose, galactose, mannose, xylose, maltose, glycerol, mannitol, dulcitol, rhamnose, sorbitol and dextrin. Arabinose, inositol, lactose, sucrose, salicin, inulia, raffinose and trebalose not attacked.

Reduces trimethylamine oxide (Wood and Baird, loc. cit ).

Hydrogen sulfide not produced. Optimum temperature 37°C.

Aerobic, facultative Antigenie structure: VI, VII: c: 1,  Serologically identical with Salmonella typhisuis, and cross-agglutinates to a varying degree with a number of other serotypes

Habitat and source. Natural host the pig as an important secondary invader in the virus disease, hog cholera. Does not occur as a natural pathogen in other animals, although lethal for mice and rabbits on subcutaneous injection. Occasionally gives rise to acute gastro-enteritis and enteric fever in man.

30a. Salmonella choleraesuis var Kunzendorf Schütze et al.

The synonyms up to and including Weldin, 1927 for Salmonella choleraesuis apply equally well to the var. Kunzendorf, for these were not separated with certainty until 1926 (White, Med. Res Council, London, Spee Rep. Ser 103, 27). Re-examined scrologically a number of previously described strains agree (Paratyphus C Bawith this variety eillus, Heimann, Cent f Bakt , I Abt , Orig , 66, 1912, 211; Paratyphosus C, Weil and Saxl, Wien klin Webnsehr, 30. 1917. 519: Typus-suipestifer Kunzendorf, Pfeiler, Zischr. f Infektskr il Haust , 20, 1920, 218; Bacillus paratuphosus B, G type, Schutze, Lancet, 1, 1920, 93, Bacillus paratyphosus C, Dudgeon and Urquart, Lancet, 2, 1920, 15, included in Group II suspestifer, Andrewes and Neave, Brit. Jour Exp. Path , 2, 1921, 157 and Group V of Heeht-Johansen, Copenhagen, 1923; Salmonella suspestifer (European variety) Schütze, Brit Jone Cap. Path , 11, 1939 31, Typus-surpestifer Kunzendorf, Kauffmann, Zhl f. d gen. Hyg , 25, 1931, 273, Salmonella choleraesus var. Lunzendorf Schütze et al , Jour Hyg , 34, 1931, 311, the European Salmonella suspestifer of many authors )

Indistinguishable from Salmonella cholerocaux in morphology and cultural characters, except that the Kunzendorf variety forms hydrogen salfole

Antigonic structure- VI VII-[c] 1.5

lacking the specific flagellar phase; serologically identical with Salmonella typhisuis var. roldagsen.

Source: From pigs with swine fever and once from a monkey in captivity. Habitat: Causes acute gastro enteritis and enteric fever in man. Also found in cattle, sheep, carnivora and chickens.

31. Salmonella typhisuls (Glässer) Schütze et al. (Bacıllus tuphisuis Glasser, Deutsche tierärztl, Wehnschr., 17. 1909, 5t3; included in the Ferkeltyphus bacilli of German literature, Dammann and Stedefeder, Arch, f. wiss, u. prakt. Tierheilk., 36, 1910, 432; Bacillus glässer Neukirch, Ztsehr. f. Hyg, 85, 1918, 103; Bacterium tuphi-suis Holland, Jour. Baet., 5, 1920, 221; included in Group I suipostifer, Andrewes and Neave, Brit. Jour. Exp. Path., 2, 1921. 157; Typus-Glasser, Kauffmann, Zbl. f. d. ges Hyg., 25, 1931, 273; Schutze et al , Jour. Hyg , 54, 1934, 342.) From Greek, typhus and Latin, pig.

Rods: 0 6 to 0.7 by 2 0 to 3.0 microns, occurring singly. Motile with four to five peritrichous flagella. Gram-nega-

Gelatin colonies: Grayish, smooth, flat, glistening, edge entire. No liquefaction.

Agar colonies Grayish, moist, smooth, translucent.

Broth: Turbid.

Litmus milk; Slightly sold or neutral. Indole not formed.

Nitrites produced from nitrites.

Forms gas slowly and sparsely from all substances. Growth poor on all ordinary media.

Acid from arabinose, x) lose and tredefined Delayed or variable fermentation from dectrin, maltose, rleamnose, dulcital, sorbitel. Mannitel not fermented or very slowly. Inositel not fermented

Nn HS produced

Optimum temperature 37 °C.

Aerobie, facultative

Antigenic structure: blentical with Salmonella choleracquis, from which the organism differs in respect to arabinose and trehalose. Antigenie structure VI, VII: c: 1, 5....

Habitat: Infects only the pig.

31a. Salmonella typhisuis var. voldagsen Schütze et al. (Ineluded in Ferkeltyphus bacilli, Dammann and Stedefeder, Arch. f. wiss u. prakt. Tierheilk., 56, 1910, 432; Bacillus voldagsen Neukireh, Ztschr f. Hyg., 85, 1918, 103; included in Group II suipestifer, Andrewcs and Neave, Brit. Jour. Exp. Path., 2, 1921, 157; Typus-voldagsen, Kauffmann, 2bl. f. d. ges. Hyg., 25, 1931, 273; Salmonella typhisuis var. voldagsen, Schütze et al., Jour. Hyg., 34, 1934, 342)

Morphology and cultural characters identical with those of Salmonella tunhisuis.

Antigenic structure: VI, VII: [c]: 1, 5.... Identical with that of Salmonella choleraesuis var. Kunzendorf from which species the organism differs culturally.

Habitat: Infects only the pig.

32. Salmonella sp. (Type Thompson). (Thompson type of Salmonella, Scott, Jour. Hyg, 25, 1925, 393; Typus-Thompson-Berlin, Kauffmann, Zbl. f. d. ges. Hyg, 25, 1931, 273; Salmonella thompson Schutze et al., Jour. Hyg., 34, 1934, 343.) Named after the family involved in the outbreak.

Antigenie structure, VI, VII: k:

Source. Isolated from food poisoning in man. Also found in chickens and turkeys (Edwards and Bruner, Jour. Inf. Dis., 72, 1943, 64)

Habitat Widely distributed in warmblooded animals

32a Salmonella sp. (Type Berlin) (Type Thompson) (Typus-Berlin, Kaufmann, Cent. f. Bakt., I Abt., Ref., 94, 1929, 282; Typus C Berlin, Boecker and Kauffmann, Cent. f. Bakt., I Abt., Orig., 116, 1930, 458, Typus-Thompson-Berlin, Kauffmann, Zbl. f. d ges. Hys., 25, 1931, 273; Salmonella thompson var. berlin Schütze et al., Jour. Hyg., 34, 1934, 343.)

Antigenic structure: VI, VII: [k]: 1,

5. . . .

Source: Isolated from food poisoning in man. Not known to be a natural pathogen of animals.

Habitat: A natural pathogen of man causing food poisoning

33. Salmonella sp. (Type Montevideo). (Salmonella montevideo Hormacche and Peluffo, Arch. Urug. de Med., Cirug y Espec., 9, 1936, 673.)

Antigenic structure: VI, VII: g, m, s: --.

Source: Originally isolated from human sources in Montevideo from a spetbat died of an entercoolitis, and mesereric glands of healthy hogs; also reported from chickens and powdered eggs (Schneider, Food Research, II, 1946, 313).

Habitat: Apparently widely distributed.

34. Salmonella sp. (Type Oranier-burg). (Typus-Oranienburg, Kaufmann, Ztschr. i. Hyg., 111, 1993, 233. Salmonella oranienburgensis Haupt-Ergebnisse der Hyg., 13, 1932, 673; Salmonella oranienburg Schütze et al., Jour. Hyg., 34, 1934, 343.)

Antigenic structure: VI, VII:m, t-Source: From the feces of a child in a children's home near Oranienburg. Later isolated from gastroeneritis in mar-Also from quail, chickens and ponderel eggs (Schneider, loc. cit.).

Habitat: Reported from human sources, from hogs and from birds.

Salmonella sp. (Type Virchon).
 Typus-Virchow, Kaulimann, Zischt. I
 Hyg., 111, 1930, 221; Salmonella rir.
 chotri Haupt, Ergebnisse der Hys. 1, 1932, 673; Salmonella virchow Schütze et al., Jour. Hyg., 84, 1934, 343.)

Antigenic structure: VI, VII; r: 1.

2, 3. . . .

Source: Isolated from food poisoning in a man at the Rudolf Virchow Hospital in Berlin.

Habitat: A natural pathogen of man causing food poisoning.

36. Salmonelfa sp. (Type Oslo). (Salmonella osla Tesdal, Ztschr. f. Hyg., 119, 1937, 451.)

Antigenic structure: VI, VII: a: e,

Source: Isolated in Oslo, Norway from cases of gastroenteritis in man.

Habitat: Not reported from other sources as yet.

 Salmonella sp. (Type Ameraloort) (Salmonella amersfoort Henning, Jour

Hvg . 57, f937, 561) Antigenie structure: VI, VII: d: e,

n, x. . . Source. Originally isolated from chickens from Amersfoort, Transvaal. Later found in a human mixed infection

with Salmonella lyphi murium Habitat: Not reported from other sources as yet.

38. Salmonella sp. (Type Brachderup). (Salmonella braenderup Kauffmann and Henningson, Ztschr. f Hyg., 120, 1937,

Antigenie structure VI, VII: e, h. e. B. Zn . . .

Source: Isolated from a case of human gastroenteritis in Braenderup, Denmark Also from a cat in the same home that had died from a diarrhoca. Reported fater from So. Africa (see Kauffmann, Die Bakteriologie der Salmonella-Gruppe, Kopenhagen, 1941, 237).

Habitat · Apparently widely tributed

39 Salmonella sp. (Type Potedam) (Typus Potsdam, Kauffmann and Mitsui, Ztschr. f Hyg., 111, 1930, 740; Salmonella potsdamensis Haupt, Ergebmisse der Hyg., 13, 1932, 673; Salmonella potsdam Schütze et al., Jour. Hyg., 34. 1934, 343.)

Antigenic structure: VI, VII: !, v: e. n. zm . . .

Source: Isolated from food poisoning in man at Potsdam, Germany.

Habitat: A natural pathogen of man causing food poisoning.

40. Salmonefla sp. (Type Bareilly). (Salmonella, Type Bareilly, Bridges and Scott, Jour. Roy. Army Med Corps. 50. 1931, 241: Salmonella bareilly Schutze et al., Jour Hyg., 34, 1934, 313 )

Antigenic structure: VI, VII; y: 1, 5. . . .

Source: Isolated in 1928 from eases of mild enteric fever that occurred in Bareilly, India, Also reported from chickens (Kauffmann, Die Bakteriologie der Salmonella Gruppe, Kopenhagen, 19 f2, 2351,

Habitat: A natural pathogen of man causing gastroenteritis and enteric fever. Widely distributed in fowls

41 Salmonella sp. (Type Hartford). (Salmonella hartfard Ednards and Bruner, Jour. Inf. Dis., 69, 1911, 223.)

Antigenie structure: VI, VII: y:

Source: One culture isolated from the stool of a man with persistent diarrhoes by Dr. E. K. Borman, Hartford, Conn.

Habitat: Not reported from other sources as yet

42. Salmonella sp. (Type Mikawasima\*). (Salmonella bareilly var. mikawasıma Hatta, Japan Jour, Exper, Med., 16, 1938, 201; Salmonella mikawasims Hormaeche, quoted from Schütze et al., Proc. 3rd Internat, Cong Microbiol., 1940, 337; also see Kauffmann, Acta Path. et Microbiol. Scand., 16, 1939. 317 and ibid , 17, 1910, 429.)

Antigenie structures: VI, VII: y: C, R, 211. . .

\*Correct spelling according to Prof. Kojima.

Source: Isolated from a rat by Prof. Kojima and Prof. Hatta, 1937.

llabitat: Not reported from other sources as yet.

43. Salmonella sp. (Type Tennessee). (Salmonella tennessee Bruner and Edwards, Proc. Soc. Exp. Biol. and Med, 50, 1942, 174.)

Antigenie structure: VI, VII: z<sub>2</sub>: —.
Source: Culture isolated from feces of normal earrier by Dr. W. C. Williams, State Dept. of Health, Nashville, Tennessee.

Habitat: Also reported from turkeys and powdered eggs.

44. Salmonella sp. (Type Concord). (Salmonella var. concord Edwards and Hughes, Jour. Bact., 47, 1944, 574.)

Antigenie structuro: VI, VII: 1, v:

1, 2, 3 . . .

Source: Two cultures isolated by Dr. J. R. Beach and one by Dr. C. U. Duckworth from fatal infections in chicks (U. S. A.) and one by Dr. Joan Taylor from the stool of a person affected with gastroenteritis (England).

Habitat: Also reported from turkeys.

45. Salmonella sp. (Type Infantis). (Salmonella infantis Wheeler and Borman, Jour Bact., 46, 1943, 481.)

Antigenic structure. VI, VII: r. 1,

Source. Isolated at Hartford, Connecticut from the blood of an infant. Subsequently also from stools.

Habitat Not reported from other sources as yet.

46. Salmonella sp. (Type Georgia). (Salmonella georgia Morris, Brim and Sellers, Amer Jour Pub. Health, 54, 1944, 1279; Seligmann, Saphra and Wassermann, Amer. Jour. Hyg, 40, 1944, 227)

Antigenic structure VI, VII b.

Source Isolated by Miss Jane Morris

from the feces of a 16-year-old boy during routine examination of food handlers, State Dept. of Health, Atlanta, Georga

Habitat: Not reported from other sources as yet.

47. Salmonella sp. (Type Papua). (Salmonella papuana Wilcox, Edwards and Coates, Jour. Bact., 49, 1945, 511)

Antigenic structure: VI, VII. r.

e, n, z<sub>16</sub>. . . .

Source: Isolated by Lt. Goldwasser from human feces from Port Moresby in Papua, New Guinea.

Habitat: Not reported from other sources as yet.

48. Salmonella sp. (Type Richmond). (Salmonella richmond Moran and Edwards, Proc. Soc. Exp. Biol, and Med., 62, 1946, 294.)

Antigonic structure: VI, VII: y: 1, 2, 3 ...

Source: Isolated by Mr. Forest Spindle in Richmond, Virginia from the feces of a child affected with gastroenteritis Habitat: Isolated as yet from human sources only.

49. Salmonella sp. (Type Cardif). (Salmonella cardiff Taylor, Edward and Edwards, Brit. Med. Jour., 1945, i, 368) Antigenic structure: VI, VII: k. i,

Source: Isolated from human case of gastroenteritis from Cardiff, Wales.

Habitat. Isolated as yet from human sources only.

50. Salmonella sp. (Type Daytons) (Salmonella daytona Moran and Edwards, Proc. Soc. Exp. Biol and Med, 62, 1916, 294)

Antigenic structure VI, VII- k: 1,

Source: Isolated by Mrs Mildred Gslton from human feces from Dayton, Florida.

Habitat: Not known from other sources as yet.

51. Salmonella sp. (Type Newport). (Paratyphus \$2, Weil and Saxl, Wien klin, Wchnschr., 30, 1917, 519; Bacillus naratunhosus B. Newnort type, Schutze. Lancet, 1, 1920, 93; Paratyphus Newport Bacillus, Kauffmann, Cent f Bakt, I Abt , Ref., 94, 1929, 282, Salmonella newport Schütze, Brit, Jour. Exp Path . 11, 1930, 34; Salmonella newportensis Haupt, Ergebnisse der Hyg, 15, 1932, 673.)

Antigenic structure VI, VIII e, h 1, 2, 3 .

Source. Isolated from food poisoning in man, Newport, England

Habitat, Widely distributed in man, cattle, hogs, chickens, etc. Also in snakes (Hinshaw and McNeil, Amer Jour Vet. Res . 6, 1945, 264)

51a. Salmonella sp (Type Puerto Kauffmann (Jordan. Amer Jour. Tron Dis. 14, 1931, 27, Kauffmann. Cent f. Bakt., I Abt. Orig., 152, 1934, I62; Schütze et al . Jour Hyg , 54, 1931. 344.)

Antigenic structure VI, VIII [c, li] 1, 2, 3 . .

This is regarded as a non-specific variant of Salmonella sp. (Type Newport) by Schütze et al. (Proc 3rd Internat, Cong Microbiol., New York, 1910, 833).

52 Salmonella sp. (Type Puerrs) (Salmonella pueris Wheeler and Borman,

Jour. Bact., 46, 1913, 481.) Antigenic structure VI, VIII. e. h

1, 2, , , . Source: Isolated at Hartford, Connecticut from anal swabbings of a I4year-old boy during an attack of gastro-

Habitat; Not reported from other sources as yet.

enteritis complicating measles

53. Salmonella sp. (Type Kottbur). (Salmonella newport var. Lottbux Kauffmann, Cent. f. Bakt., I Abt , Orig., 152, 1934, 162; Salmonella kottbus Schütze et al., Proc. 3rd Internat. Microbiol. Cong , New York, 1940, 834 )

Antigenic structure: VI, VIII: c. h. 1, 5 . . . Source. From an acute case of gastro-

enteritis in Kottbus. Denmark

Habitat. Not reported from other sources as yet

54 Salmonella sp. (Type Muenchen). (Typus München, Mandelbaum, Cent. Bakt , I Abt., Ref , 105, 1932, 377; Salmonella muenchen Schütze et al., Jour Hyg., \$4, 1934, 311.)

Antigenie structure: VI, VIII. d: 1. 2. .

Source: Isolated from a fatal case of enteric fever.

Habitat. Widely distributed, Reported from man, rabbits, hogs, camels and chiekens (Kauffmann, Dio Baktenologie der Salmonella Gruppe, 1911. 244)

54a. Salmonella sp. (Type Oregon). (Salmonella oregon Edwards and Bruner. Amer Jour Hyg., 54, 1911, 21)

Antigenic structure: VI, VIII: d: 1. 2.3 . .

Source. Six cultures, one isolated from a turkey by Dr. Il. M. Dickinson and five from the mesenteric glands of apparently normal hogs by Dr H. L. Rubin. This is a minor type of No 51

Habitat Also reported from reptiles. chickens and man Also powdered eggs.

55. Salmonella sp. (Type Manhattan). (Salmonella manhattan Lidwards and Bruner, Amer Jour Hyg., 34, 1911, 21 ) Antigenic structure: VI, VIII. d.

1. 5. . . . Source: Two cultures, one isolated from a chicken by Dr. L. D. Bushnell.

Manhattan, Kansas, and the other from a turkey by Dr. W. R Hinshaw, Also from reptiles, hogs and human sources (Edwards and Bruner, Jour. Inf. Dis., 72, 1942, 64).

Habitat: Apparently widely distributed.

56. Salmonella sp. (Type Litehfield). (Salmonella litchfield Edwards and Bruner, Jour. Inf. Dis., 68, 1940, 220.)

Antigenic structure: VI, VIII: 1, v: 1,2,3....

Source: Isolated from the liver of a young turkey poult from Litebfield, Minnesota by Dr. B. S. Pomeroy. Also isolated from a case of food poisoning in man by Miss Georgia Cooper.

Habitat: Not reported from any other source, as yet.

57. Salmonella morbificans (Migula) Haupt. (Bacillus bowis morbificans Basonau, Arch. f. Hyg., 20, 1894, 257; Bacillus morbificans bows Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., \$, 1896, 899; Bacterium morbificans bowis Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., \$, 1807, 70; Bacillus morbificans Migula, Syst. d. Bakt., \$, 1900, 747; Flaubacterium morbificans Bergey et al., Manual, 3rd ed., 1930, 147; Haupt, Ergebnisse der Hyg., 15, 1930, 673; Salmonisel bowis-morbificans Schütze et al., Jaur. Hyg., 34, 1934, 344.)
Antigenie structure. VI, VIII: r:

1, 5. . . .

Source: Originally isolated from a senticemia in a cow.

Habitat: Also found in rabbits and in gastroenteritis in man.

58. Salmonella sp. (Type Narashino). (Salmonella narashino Nakaguro and Yamashita, quoted from Kaufimana, Die Bakteriologie der Salmonella-Gruppe, Kopenhagen, 1941, 246.)

Antigenic structure: VI, VIII: a: e,

Source. From the blood and feces of a

person suffering from enteric fever, Found in Japan.

Habitat: Not reported from other sources as yet.

Salmonellasp. (Type Buenos Aires).
 (Salmonella bonariensis Monteverde, Nature, 149, 1942, 472.)

Antigenic structure: VI, VIII: i.

Source: Isolated by Dr. Monteverde, Buenos Aires from a mesenteric gland of a normal hog.

Habitat: Also reported from normal human carriers and from cases of gastroenteritis.

60. Salmonella sp. (Type Glostrup). (Salmonella glostrup Kauffmann and Henningsen, Acta Path. et Microb. Scand., 18, 1939, 99.)

Antigenic structure: VI, VIII: zn: e,

n, 216....
Source: Isolated from cases of gastroenteritis in a family in Denmark. Also
enfected their dog. Later isolated in
Jucoslavia and in Palestine.

Habitat: Evidently widely distributed.

 Salmonella sp. (Type Duesseldorl).
 (Salmonella duesseldorf Hohn, Cent. f. Bakt., I Abt., Orig., 146, 1940, 218)

Antigenic structure: VI, VIII: 24, 221:

Source: Isolated from two patients, and of whom died. Found in Duesseldorf, Germany.

Habitat: Not reported from other sources as yet.

Salmonella sp. (Type Tallahassee).
 (Salmonella tallahassee Moran and Edwards, Proc. Soc. Exp. Biol. and Med.
 1946, 294.)

Antigenic structure: VI, VIII: 20,

Saurce: Isolated by Mrs. Mildred Gal-

ton from feces of gastroenteritis patients and from normal human earriers, Tallahassee, Florida.

Habitat: Not known from other sources.

63. Salmonella sp. (Type Gatun). (Salmonella gatuni Wilcov and Coates, Jour Bact., 51, 1916, 561.)

Antigenic structure, VI, VIII: b: e, n, x. . .

Source: Isolated from human feces from Gatun, Canal Zone.

Habitat: Not known from other sources as yet.

64. Salmonella sp. (Type Amherst) (Salmonella amherstiana Edwards and Bruner, Jour. Immunol, 44, 1912, 319.) Antigenie structure: (VIII). I, v. I.

Source, Isolated by Dr. II. Van Rockel from one of a group of poults affected with a fatal disease.

Habitat: Not reported from other sources as yet.

65. Salmonella sp. (Type Virginia). (Salmonella virginia Saphra and Seligmann, Proc. Soc. Exper. Biol. and Med, 58, 1945, 50)

Antigenie structure: (VIII): d: — Source, Isolated by P. Spindle, Richmond, Virginia from the feces of an adult person suffering from a distrinces.

Habitat: Not known from other sources as yet.

60. Salmonella typhosa (Zopf) White-(Bacillus des Abdominal-Typhus, Elevith, Arch. f. path. Anat., 87, 1889) and 83, 1881; Typhus bacillen, Gafflay, Mittell a d. knierl. Geundheitsaude, 2, 1881, 372; Hacillus typhonus Zopf, Die Spiltpile, 3, Auf., 1885, 162; not Bacillus typhosus Elebs, Handbuch d. path Anat., 1880; Bacillus typh Schroeter, in Cohn, Kryptogamer Flora v. Schlesien, 3, 1886, 165. Bacillus typhi abdominalis Flügge, Die Mikroorganismen. 2 Aufl., 1886, 198; Vibrio typhosus Trevisan, I generi e le specie delle Batteriacec, ISSO, 23; Bacterium typhi Chester, Ann. Rept. Del. Col. Agr. Exp Sta., 9, IS97, 73; Bacterium typhosum Twort, Proc. Royal Soc., London, 79, B, 1907, 329; Acystia tuphi Enderlein, Sitzber, Gesell, Naturf. Freunde, Berlin, 1917, 517; Bacterium (Lberthella) typhi Buchanan, Jour. Baet , 3, 1918, 53; Eberthus typhosus Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 936; Eberthella tuphi Bergev et al., Manual, 1st ed., 1923, 223; Eberthella tuphosa Weldin, Iona State College Jour. Sci., 1, 1927, 170: Salmonella tuph: Warren and Scott. Jour Hyg., 29, 1930, 416; White, Jour. Hyg , 29, 1930, 443 ) Named from the disease, typhoid fever.

The species name typhose should be used for the typhoid organism when it is placed in any genus other than Bacillus in spite of the earlier use of this species name by Klebs for a different organism. There are two reasons for this. (a) This appears to be the proper course to follow under International Rules of Nomenclature (See Art. 51, p. 51) and (b) there is less chance for confusion regarding the nature of this organism among English-speaking persons who may careleady interpret typhia is the name of a typhus rather than a typhoid bacillus.

Bods: 0 6 to 0.7 by 2 0 to 3 0 microns, occurring singly, in pairs, occasionally short chains Motile with pentrichous flarella. Gram-negative.

Gelatin colonies. Grayish, transparent to opaque, with leaf-like surface markings

Gelatin stab. Thin, white, opalescent growth. No liquefaction

Agar colonies: Grayish, transparent to opaque.

Agar slant; Whitish-gray, glistening, echinulate, entire to undulate growth

Broth: Turbid, moderate sediment and delicate pellicle in old cultures.

Litmus milk: Slight, transient acidity, followed by a return to neutral or to slight alkalinity.

Potato: Delicate, moist, slightly spreading, barely visible growth.

Acid but no gas from glucose, fructose, galactose, xylose, maltose, raffinsee, dextrin, glycerol, mannitol and sorbitel. No action on lactose, sucrose, inulin, rhamnose, inositel, salicin nnd usually srabinose and dulcitol.

Reduces trimethylamine oxide (Wood and Bard, loc. cit ).

Indole not formed.
No characteristic odor.
Nitrites produced from nitrates.
Hydrogen sulfide produced.
Aerobie, facultative.

Optimum temperature 37°C.

Antigenie structure: IX, XII, IVI;
d— The somatic antigens are related
to those of Salmonella enteritudis and a
number of other species of Salmonella.
V and W forms are present (Felix and
Patt, Jour. Path and Baet., 33, 1934,
409, Craigie and Brandon, Jour. Path.
and Baet., 43, 1936, 233 and 230,
Craigie and Yen (Canadian Public
Health Journal, 29, 1938, 448 and 481)
by the action of selected Vi phages recognize eleven distinct stable types of
Salmonella typhosa which have been
found to be of epidemiological impor-

Source. From the human intestine.

innce

Habitat The cause of typhoid fever Pathogenic for laboratory animals on parenteral injection Isolated Oncefrom a chicken by Henning, Onderstepoort. So Africa

Nore This species has previously been regarded as the type species of the genus Eberthella Buchanan (Acustia Enderlein, Sitzber. Gesell. Naturf. Freunde, Berlin, 1917, 317; Buchanan, Jour. Baet , 3, 1918, 53; Eberthus Castellani and Chalmers, Man Trop. Med., 3rd ed., 1919, 934; Lankoides Castellani and Chalmers, ibid., 938; Wesenbergus Castellani and Chalmers, ibid., 940)

67. Salmonella enteritidis (Gaeriner) Castellani and Chalmers. (Bacillus enteritidis Gaertner, Correspond. d. Allgemein. Artzl. Verein Thuringen, 17, 1885, 573; Klebsiella entertidis De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 6, 1889, 923; Bacterium entertidis Chester, Ann. Rept. Del. Col. Agr. Ep Sta., 9, 1897, 68; Bacillus gartner Morgan, Brit. Med. Jour., 1, 1905, 123; Castellani and Chalmers, Manual Trop. Med., 3rd ed., 1919, 930.) Named for the disease, enteritis.

Rods: 0.6 to 0.7 by 2.0 to 30 micrors, occurring singly, in pairs and occasionally in short chains. Motile with pertrichous flagella. Gram-negative.

Gelatin colonies: Circular, gray, trans-

Gelatin stab: Abundant surface growth, No liquefaction.

Agar colonies: Circular, gray, tranlucent, moist, smooth, entire. Desiowitz and Buchbinder (Jour. Bast, 28, 1935, 294) describe a variant that produces a soluble yellow pigment where certain peptone is present in the agar. Antigenic structure not determined.

Agar slant: Grayish-white, opalescent, smooth, moist, uadulate growth.

Broth: Turbid, with thin pellicle and grayish-white sediment.

Litmus milk: Slightly acid, becoming alkaline, opalescent, translucent to yellowish-gray.

Potato: Abundant, moist, yellowishbrown to brown growth.

Indole not formed.

Nitrites produced from nitrates.

Acid and gas from glucose, fructose,

Acid and gas from gudoss, vylose, maltose, trahalose, arabinose, xylose, maltose, trahalose, dettrin, glycerol, mannitol, dulcitol and sorbitol. No acid or gas from lactose, sucrose, nulin, salicin, raffinose, adonitol and inositol.

Reduces trimethylamine oxide (Wood and Baird, loc. cit.).

Hydrogen sulfide produced.

No characteristic odor. Aerobic, facultative

Optimum temperature 37°C.

Antigenic structure: [1], IX, XII.

Source: First isolated from feces in an epidemic of meat poisoning at Frankenhausen, Germany.

Habitat: Widely distributed, occurring in man. Also in domestic and wild animals, particularly rodents

67s. Salmonella entertidis var. Danysz. (Bahr. Deutsche tverärzil Wehnschr. 1928, 788 and 1930, 145, Typus-Gärtner Ratin, Kauffmann, Zbl. f. d., ges. 11yg., 28, 1931, 273, Salmonella entertidis var. danysz. Schütze ct. al., Jour 11yg., 34, 1934, 315; Salmonella danysu Gay et al., Agents of Disease and 11ost Resistance, 1935, 659

Differs from Salmonella enteritidis only in its negative action on glycerol in Stern's medium.

Source: Isolated by Danysz in 1900 Habitat: A natural pathogen of re-

dents and man.

67b Salmonella entertitats var. Chaco (Savino and Menendez, Rev Inst Hact, 6, 1934, 347; Kauffmann, Ztschr f. Hyg., 117, 1935, 401.)

Differs from Salmonella enteritidis in its action on dulcitol when tested by the method of Bitter, Weigmann and Habs (Münch, med. Wehnschr, 75, 1926, 910)

Habitat and source: Isolated from cases of fever during the Chaco war, South America.

67c. Salmonella enteritidis var Essen (Hohn and Herrmann, Cent. f Bakt, I Abt, Orig, 133, 1935, 183; 151d., 134, 1935, 277; Kauffmann, Ztschr. f. Ilyg, 117, 1935, 401)

Differs from Salmonella entertidis when tested by the method of Bitter, Weigmann and Habs (Münch, med. Wchnschr, 73, 1926, 910), giving a negative reaction with arabinose and dufcitol.

Habitat and source: Isolated from human gastroenteritis, ducks and duck eggs.

Note: Jansen (Cent. f Bakt., I Abt., Orig., 155, 1935, 421) states that the organism named by him Salmonella enteritidis var. Mulheim is in reality Salmonella enteritidis yar Essen.

67d. Salmonella enteritidis var. Jena. (Fournier, Rev. Immunolog., Paris, 6, 1940-41, 264)

Source: Isolated from purulent pleural

Habitat Not reported from other sources as yet

68. Salmonella sp. (Type Dublin), Bacillus entertidis Peech, Cent. f. Bakt, 1 Abt., Ong. 98, 1920, 22; Jublin Type, White, Med Res Coune. Syst. of Beet. 4, 1922, 86 and White, Jour Hyg., 29, 1930, 443, Salmonella dublin Warren and Scott, Jour Hyg., 29, 1930, 415, Typus-Dublin-Kiel, Kauffmann, Zbl. f. d. ges. Hyg., 25, 1931, 273; Salmonella entertidis var dublin Schittze et al., Jour Hyg., 34, 1931, 315)

Antigeme structure I, IX, XII- g,

p —. Source From meningitis in children (Peech, loc. cit) Also isolated by Dr. J W Bigger in Dublin, Eire from a fatal fever following a kidney operation Typed by Dr. Bruce White (loc. cit).

Habitat Found in man A natural pathogen of cattle Widely distributed in cattle and foves

Two special fermentative (3 per belong here (1) Salmontlla dublin 2 - Salmonella dublin var acera Kauffmann, (2) Salmonella dublin var keeln Kauffmann (Die Bakteriologie der Salmonella-Gruppe, Kopenkagen, 1911, 252).

69 Salmonella sp. (Type Rostock). (Gärtner-Poppe Typus, Rahr, Disch. Tierärzt, Welmschr, 1930, 145; Typus Gärtner-Rostock, Kaufimann, Ztschr. f. Hyg., 111, 1930, 221; Salmonella enteritidis var. rostock Schütze et al., 34, 1934, 315; Salmonella rostockensis Haupt, Ergebnisse der Hyg., 13, 1932, 673.)

Antigenic structure: I, IX, XII: g, p, u: -.

Source: Originally isolated from cattle by Dr. Poppe in Rostock, Germany. Habitat: Not known to infect man.

70. Salmonella sp. (Type Moscow). (Paratypus C., Weigmann, Cent. f. Bakt., I Abt., Orig., 97, 1925, Beiheft, 290; Salmonella Type Moscow, Hicks, Jour. Ilyg., 29, 1929, 446; Salmonella moscow Warren and Scott, Jour. Hyg., 29, 1929, 446; Typus Gärtner-Moskow, Kaufimaun, Ztschr. f. Hyg., 11, 1939, 220; Salmonella moscoacansis Haupt, Ergebnisse der Hyg., 13, 1932, 673; Salmonella enterituis var. moscow, Schutze et al., 34, 1934, 345).

Antigenic structure. IX, XII: g, q: --.
Source From patients with enteric
fever. Isolated in Moscow, Russia.

fever. Isolated in Moscow, Russia. IIabitat Infects man, horses, cattle.
71 Salmonella sp. (Type Blegdam).

(Salmonella blegdam Kauffmann, Ztschr. f. Hyg., 117, 1935, 431.) Antigenic structure. 1X, XII: g,

Antigenic structure. IX, XII: m, q: -

Source: Isolated in 1929, at State Scrum Institute, Copenhagen from the blood of a pneumonia patient. Also found in the blood of a patient by Dr. Fourmer, in Shanghai, China (Kauffmann, Die Bakteriologie der Salmonella-Gruppe, Kopenhagen, 1941, 264).

Habitat: Not reported from other sources as yet

72 Salmonella sp. (Type Berta). (Salmonella berta Hormacche, Pelulfo and Salsamendi, Arch. Urug de Med., Cirug. y Espec., 12, 1938, 277) Named in honor of Prof. Arnoldo Berta, Uruguay

Antigenic structure 1X, X1I: f, g,

Source: Isolated from the mesentence glands of normal hors.

Habitat: Causes gastroenteritis in man. Also found in chickens.

73. Salmonella sp. (Type Pensacola). (Salmonella pensacola Moran and Edwards, Proc. Soc. Exper. Biol. and Med., 59, 1945, 52.)

Antigenie structure: IX, XII: g, m, t: -.

Source: From a severe case of gastroenteritis in man.

Habitat: Not reported from other sources as yet.

74. Salmonella sp. (Type Claibome). (Salmonella claibornei Wilcox and Leanox, Jour. Immunol., 49, 1944, 71.)

Antigenic structure: I, IX, XII: k-1, 5. . . .

Source: Culture isolated from human feces at Camp Claiborne, Louisiana. Habitat: Not known from other

Habitat: Not known from othe sources as yet.

75. Salmonella sp. (Type Sendas). (K type, Shimojo, quoted from Kaufmann, Die Bakteriologie der Salmontella Gruppe, Kopenbagen, 1941, 265; Atype cal Paratyphosus A, Aoki and Sakai, Cent. f. Bakt., I Abt., Orig., 35, 1925, 152; Sendai type, White, Med Res Council, Spee. Rept. Ser. No. 103, 1928, 118; Salmonella sendaiensis Haupt. Ergebnisse der Hyg., 15, 1932, 673; Salmonella sendai Schütze et al., Jour. Hyg., 34, 1934, 345; Eberthella 19 (Sendai Type) F. Smith, in Manual, 5th ed., 1939, 461.)

Antigenic structure: [I], IX, XII. s.

1, 5. . . .

Source: Isolated in 1922 by K. Shimojo in Japan from a case of paratyphoid. Later isolated by Aoki and Sakoi from feces, urine and blood of typhoid patients.

Habitat: A natural pathogen of man causing enteric fever. 76. Salmonella sp. (Type Miami). (Solmonella miami lidwards and Moran, Jour. Bact., 50, 1945, 259)

Antigenic structure IX, XII: a: 1, 5....

Differ culturally and biochemically from organisms of Sendai Type (Edwards and Moran, Jour Bact., 50, 1945, 257).

Source. Twenty-four cultures isolated by Mrs. Mildred Galton in Florida. Fourteen cultures were from cases of acute gastroenteritis, one from a nationt with chronic diarrhoea, 4 from food handlers. 4 from chimpanzees thought to be affected with bacillary dysentery and one from pickles which caused an outbreak of food poisoning. One culture was from Borman, Wheeler, West and Mickle (Amer Jour Pub. Health. 53, 1913, 127) and was isolated from a case of gastrocuterities in Connecticut Another culture was from Schgmann, Saplus and Wassermann (Amer. Jour Hyg., 38 1943, 225) and was isolated from a case of enteric fever

Habitat apparently widely distributed as a natural pathogen of manand ages

77. Salmonella sp. (Type Durban) (Salmonella durban Henning, Bhodes and Gordan-Jahustane, Onderstepoort Jour Vet. Sei. An Ind., 164, 1944, 103, also ste Kauffmann Veta Pith et Microbaol Seand., 19, 1942, 543)

Antigenic structure IX, XII a c,

n, z<sub>11...</sub>

Source: Isolated in Dr J Gordon-Johnstone in Durban. So Africa from feces of a noman affected with gastra-

enteritis

Habitat: Not reported from other sources as yet

78. Salmonella sp. (Type Onarimon) (Salmonella onarimon Kisida, Kitasato Arch, of Exper Med. 17, 1910, 1.)

Antigenic formula 1 IX, XII b

Source: From the feces of a paraty-

phoid B carrier. Later found in other cases of enteric fever resembling typhoid.

Habitat: Cause of a typhoid if

Habitat: Cause of a typhoid-like disease in man.

70 Salmonelle en /Toma Past. .

Antigenic structure: [1], 1X, XII; e, h: 1,5 ...

May or may not produce indole (Kauffmann, Die Bakteriologie der Salmonella-Gruppe, 1941, 12.)

Source: From human enteric fever at Easthourne, England.

Habitat: A natural pathogen for man.
Also found in turkeys.

Salmonella sp. (Type Panama).
 (Jordan, Amer. Jour. Trop. Med., 14, 1934, 27; Salmonella panama Kauffmann, Cent. I. Bakt., I Abt., Orig., 152, 1934, 160.)

Antigenie structure: I, IX, XII: I, v:

Source: From human food poisoning at Fort Amador, in Panama, Canal Zone. Also isolated in New York City, Germany and Druguay. Also in reptiles, hogs and chickens (Edwards and Druner, Jour. Int. Dis., 72, 1913, 61).

Bruner, Jour. Inf. Dis., 72, 1943, 64).
Habitat: Apparently widely distributed.

81. Salmonella sp. (Type Dar es Salaam). (Brown, Duncan and Henry, Lancet, 1, 1926, 117; Dar-ex-Salaam Typus, Schütze, Arch. I. Hyg., 100, 1928, 1925, Salmonella daversudamentsi Haupt, Ergebnisse der Hyg., 15, 1932, 673; Salmonella dar-ex-ladam Schütze et al., Jour. Hyg., 24, 1931, 316.)

Antigenic structure: I, IX, XII:1, w:

Liquefics gelatin (Jordan, Jour. Inf. Dis. \$3, 1935, 126).

Source: Is slated by Butler in 1922 from a case of pyrevia at Dar es Salaam, East Africa. Cultures have also been reported from Zannbar.

Habitat: Known thus far from human sources only.

 Salmonella sp. (Type Goettingen). (Salmonella goettingen Hohn, Cent. f. Bakt., I Abt., Orig., 146, 1940, 218.)

Antigenic structure: IX, XII: l. v: c, n, z<sub>15</sub>....

The complete formula was developed by Kauffmann (Acta Path. et Microbiol. Scand., 17, 1940, 429.)

Source: Not given. Presumably from a human source.

Habitat: Not reported.

83. Salmonella sp. (Type Java). (Salmonella javiana Alley and Pijoan, Yale Jour. Biol. and Med., 15, 1942, 229; Edwards and Bruner, Jour. Immunol., 44, 1942, 319.)

Antigenic structure. [I], IX, XII. I.

Source: From Enkman Institute in Java. Isolated from feces of a child. Subsequently two cultures labeled N112 and N140, isolated in Panama from human carriers, were received from Col. Chas G Sinclair.

Habitat. Reported as yet from human sources only.

84 Salmonella gallinarum Bergey et al (Bacillus gallinarum Klein, Cent f. Bakt., 5, 1889, 689; Pheasant bacillus, Klein, Jour Path. & Baet., 2, 1893, 214; Bacillus phasiani septicus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 410, Bacterium sanguinarium Moore, 12th and 13th Ann. Rpt. for 1895-96, U. S. Dept. Agr., Bur. An. Ind., 1897, 188, sec Moore, U. S. Dept. Agr. Bur An Ind , Bull. 8, 1895, 63; Bacıllus phasiani Migula, Syst. der Bakt , 2, 1900, 769, Bacterium phasiani septicus Chester, Ann Rept. Del. Col. Agr. Exp Sta., 9, 1897, 74; Bacterium gallinarum Chester, ibid, 80; Bacterium pyogenes sanguinarium Berry and Ernst, Jour. Med. Res., 10 (N S. 5), 1903-04, 402; Bacillus pseudo-cholerae gallinarum Trineas, Giorn, della R. Soc. Ital.

d'Igiene, 1908, 385; Bacillus typhi gallinarum alcalifaciens and Bacillus typhi gallinarum Pfeiler and Rehse, Mitt. K. Inst. f. Landw. Bromberg, 5, 1913, 306, Eberthella sanguinaria Bergey et al, Manual, 1st ed., 1923, 231; Bergey et al. Manual, 2nd ed., 1925, 236; Shroella collinarum Weldin, Iowa State Coll. Jour. Sei., 1, 1927, 179) From Latin, of chickens.

Bacterium jeffersonii Hadley, Elkins and Caldwell, Rhode Island Agr. Exp. Sta. Bull. 174, 1918, 169 (Eberthella jeffersonii Bergev et al., Manual, 1st ed . 1923, 230; Shigella jeffersonii Bergey et al , Manual, 4th ed., 1934, 394). Shigella jeffersonii is identical serologically with Salmonella gallinarum (St. John-Brooks and Rhodes, Jour. Path. and Bact., 26, 1923, 433).

Rods: 0 4 to 0 6 by 0 8 to 1 6 mherons, with rounded ends, occurring singly or (in blood) in short chains. Non-motile

Gram-negative. Gelatin colonies: Small, grayish.white, finely granular, circular, entire.

Gelatin stab: Slight, grayish-white surface growth with slight grayish, fileform growth in stab. No liquefaction

Agar colonies: Moist, graylsh, fireular, entire.

Agar slant: Thin, gray streak, with irregular margin, moist, glistehing Broth: Turbid with heavy, flocculent

sediment. Litmus milk: Reaction unchanged,

becoming translucent. No congulation

Potato: Slight grayish growth.

Indole not formed.

Nitrites produced from nitrates Acid but no gas from glucose, fructose, galactose, mannose, xylose, arabinose, maltose, devtrin, mannitol, dukitol and isoduleitol. Lactose, sucrose, glycerol, saliein and sorbitol are not attacked. Reduces trimethylamine oxide (Wood

and Baird, loc. cit.). Hydrogen sulfide is sometimes formed.

Aerobie, facultative.

Optimum temperature 37°C. Antigenie structure: [I], IX, XII:-: Identical with Salmonella pullorum, and related to Salmonella typhosa. [1] antigen noted by Kaufimann (Acta Path. et Microbiol. Scand., Suppl 54, 1944, 36).

Source and habitat The causative agent of foul typhoid (clearly to be distinguished from fowl cholera), and identical with Moore's infectious leracina of lowls. Infectious for rabbats and all poultry, canaries and certain wild birds (quali, grouse, pheasant) by

leeding or by injection. Found once in

a normal human carrier.

85 Salmonella pullorum (Rettger)
Bergey et al. (Hactersum pullorum
Rettger, Jour. Med Res. 2t (NS 18),
1909, 117; also see Rettger, N. Y Med
Jour., 7t, 1900, 803; ibd., 73, 1901, 267,
Rettger and Harvey, Jour Med Res.
18 (N S. 13), 1908, 277; Bacallus pullorum
Smith and Ten Brocck, Jour. Med. Res.
51 (N. S. 26), 1915, 547; Bergey et al.,
Manual, 1st ed., 1923, 218; Typus pullorum, Kaufmann, Zentb. 1 d. ges
Hyge., 25, 1931, 273.) From Latin, of
cluckers

Rods: 0.3 to 0.5 by 1 0 to 2 5 microns, occurring singly Non-motile. Gramnegative.

Gelatin colonies: Grayish-white, moist, lobate, with grape-leaf surface. Gelatin stab Slight, grayish surface growth. No luquefaction

Agar colonics Grayish-white, smooth,

Agar slant: Develops as discrete, translucent colonies. Broth Turbid.

Litmus milk: Acid, becoming alkaline No congulation Potato: Slow development, grayish.

Indole not formed.

Mitries produced from nitrates Acid and gas from glucose, fructise, galactose, mannose, arabinose, xilose, maunitol and rhamnose. Does not at tack lactose, sucrose, maltose, deviru, salicin, raffinose, sorbitol, adonitol, dulcttel or inositol. Gas may le slight or alsent (cf. Salmonella gallinaruse) Xylose may be fermented late (see Weldin, Iowa State Coll. Jour. Sci., 1, 1927, 165). Maltose fermenting strains may occur (Hinshaw, Browne and Taylor, Jour. Inf. Dis., 73, 1943, 197).

Reduces trimethylamine mide (Wood and Baird, loc. cit.).

Hydrogen sulfide is formed.

Acrobic, facultative

Optimum temperature 37°C.

Antigenic structure, IX, XII -:
The complete antigenic formula of

The complete antigenic formula of S pullorum SI, XII,, XII,, XIII, while that of S. gallinarum seems to be IX, XII,, XII, Antigen XII, is variable in S pullorum Edwards and Bruner, Cornell Vet., 38, 1916, 318) and XII,++ and XII,+ forms occur The XII,++ forms are syponymous with the X strains of Youne (Can. Jour Comp. Med., 5, 1911, 161)

Source: Isolated from chickens and other bitds, as well as calves, hogy, rabbits and man. Occasionally produces lood potenting or gastrocuteritis in man (Airchell, Garlock and Ilroh-Kahn, Jour. Inf. Dis., 79, 1916, 57).

Habitat: The cause of white diarrhoca in young chicks. Infects the ovaries and eggs of adult birds.

85a. Salmonella gallinarum var. Duisburg. (Müller, Münch. med Wchnschr., 80, 1933, 1771; Kauffmann, Cent. f Bakt., I Abt., Orig., 152, 1931, 237)

Antigenically identical with Salmonella nallinorim and Salmorette. "

terment d tartrate and in not forming II.s.

Source and habitat; Isolated Irom acute gastroenteritis in man

86 Salmonella sp. (Type Canastel), (Nalmonella canastel Randall and Bruner, Jour Bact., 49, 1915, 511.) Source of name not given.

Liquelies gelatin

Antigenic structure; IX, XII; sn;

Source: Isolated in North Africa from American soldiers acting as food handlers.

Habitat. Not reported from other sources as yet

87. Salmonella sp. (Type Italia). (Salmonella staliana Bruner and Edwards, Proc. Soc. Exp. Biol. and Med., 58, 1945, 289.)

Antigenic structure: IX, XII: 1, v:

Source: Two cultures, one isolated from a case of bloody diarrhoea and the other from a case of gastreenteritis in man. Found in Italy by Lt. Col. Robert Hebble and by Capt. Ira C. Evans.

Habitat: Not reported from other sources as yet.

88 Salmonella sp. (Type Napoli). (Salmonella napoli Bruner and Edwards, Proc. Soc. Exper Biol. and Med., 58, 1945, 289)

Antigenic structure. [1], IX, XII: 1, z<sub>10</sub> e, n, x. . . .

Source Ten cultures isolated from normal feces and from cases of gastro-enteritis in Naples, Italy. The first culture was isolated by Capt. W. II. Ening.

Habitat. Not reported from other sources as yet.

Salmonella sp. (Type Loma Linda).
 (Salmonella loma linda Edwards, Proc. Soc. Exper. Biol. and Med., 67, 1944, 104.)

Antigenic structure IX, XII. a. e,

Source: Single culture isolated by Dr T F. Judefind, Loma Linds, California from the spinal fluid of a baby that died of meningitis.

Habitat: Not reported from other sources as yet

90. Salmonella sp. (Type New York) (Salmonella new york Kauffmann, Acta Path. et Microbiol Scand, Suppl. 54, 1944, 35)

Antigenic structure: IX, XII: 1, v

Source: Found by Dr. F. Schiff, New York in a study of a culture received under the label S. parama Strain No 43 Regarded at the present time as a strain of Salmonella javiana by Dr. Kauffmas (personal communication, March, 1917).

Habitat: Not reported from other sources as yet.

91. Salmonella sp. (Type London) (Salmonella Type L, White, Med Res. Council Spec. Rept. Ser. 103, 1926, 37; Salmonella londonensis Haupt, Ergebiss der Hyg., 15, 1932, 675; Salmonella london Schütze et al., Jour. Hyg., 34, 1934, 39) Antigenic structure: III, X, XXVI

v: 1, 6....
Source: Isolated in London from the feces of a gastroenteritis patient from Reading, England.

Habitat: Found in human infections, in hogs and in chickens.

92. Salmonella sp. (Type Give). (Solmonella give Kauffmana, Ztschr. f. Hys. 129, 1937, 177.)

120, 1937, 177.)
Antigenie structure: III, X, XXVI.

Source: From feces of a patient with pernicious anemia. Also found in the U.S.A. and Germany. Occurs in foals and hogs (Edwards and Bruner, Jour.

Inf. Dis., 72, 1943, 64).

Habitat: Apparently widely distributed.

93. Salmonella sp. (Type Uganda) (Salmonella uganda Kaufimann, Acta Path. et Microbiol. Scand., 17, 1940, 189.)

Antigenic structure: III, X, XXVI:

Source: Isolated in Uganda by Dr. H. G. Wiltshire from a human spices on autopsy Typed by Dr. F. Kaufmann.

Habitat: Not reported from other sources as yet.

94. Salmonella anatls (Rettger and Scoville) Bergey et al. (Raternum anatis Rettger and Scoville, Abst. Bact., 5, 1910, 8, not Bacterium anatis Migula, Syst. d. Bakt., 2, 1909, 364; Bacterium anatis Mettger and Scoville, Jour Inf. Dis, 26, 1920, 217; Escherichia anatic Bergey et al., Manual, let ed., 1923, 193; Borger et al., Manual, 2nd ed., 1925, 238, Salmonella anatum Bergey et al., Manual, 3rd ed., 1930, 344.) From Latin, of the duck.

With the transfer of this organism to the genus Saimonella, the original species name anatis again becomes available in spite of the earlier use of this species name hy Migula for Gorail and Toupet's Bacillus der Enten-cholera (Comptrend Acad Sei, Paris, 106, 1888, 1737) The latter organism is stated by Rettger and Seoville (1920, loc. at, 220) to be indistinguishable from Pasteurella assessing

Morphology and cultural characters like those of Salmonella ententidis. Kauffmann (Zischr f. Hyg., 119, 1937,

352) describes a lactose-splitting variant of this species.

Antigenic structure. III, N, XXVI: e, h, 1, 6. . .

Reduces trimethylamine oxide (Wood and Baird (loc. cit).

Source: Isolated from an epizootic of keel in ducklings. Also found in intestinal infections in chickens and man frequently occurs in association with Salmonella typhimurium.

Habitat, Widely distributed in manand domestic animals

95 Salmonella sp. (T) per Muenster) (Salmonella anatum var muenster, Kauffmann and Silberstein, Cent. f. Bakt., I Abt., Orig. 152, 1934, 431; Salmonella mueneter Kauffmann, Zischr f. Hyg., 140, 1937, 147)

Antigenie structure: III, N, XXVI e, h 1, 5 . .

Source. Isolated by Dr. Besserer in Muenster from food poisoning Also isolated in Uruguay from human sources. Habitat: Not known from any but human sources as yet.

Salmonella sp. (Type Nyborg).
 (Salmonella anatum var. nyborg, Kristensen and Bojlén, Cent. f. Bakt., I
 Abt., Orig., 156, 1936, 291; Salmonella nyborg Kaulimann, Ztschr f. Hyg., 120, 1937, 189.)

Antigeme structure · III, X, XXVI; e, h: 1, 7.

Source: From a case of acute enteritis in a young girl in Nyborg, Denmark.

Ilabitat. Known only from human sources as yet

97 Salmonellasp. (Type Vejle). (Salmonella rejle Harhoff, quoted from Kauffmann, Die Bakteriologie der Salmonella-Gruppe, Kopenhagen, 1941, 274.)

Antigenic structure: III, X, XXVI:e, h. 1. 2. 3. . .

Source: Isolated by D. Møller, Copenhagen, from a case of acute gastroenteritis.

Habitat: Not reported from other sources as yet.

98. Salmonells 59. (Type Meleagris). (Salmonella meleagridis Bruner and Edwards, Amer. Jour. Hyg., 34, 1911, 82, not Salmonella meleagridis Rettger, Plastridge and Cameron, Jour Inf Dis, 53, 1933, 279)

Antigenic structure: III, X, XXVI: e, h: I, w . . .

Source. Original cultures isolated by Dr. B. S. Pomercy, Univ. of Minnesota, from two distinct outbreaks of infection in turkey poults—Stated to be the same as Salmonella bankam from Ilatavia, Java (Kauffmann, Acta Path. et Microbiol. Seand., 19, 1012, 529)

Habitat In addition to the two strains Isolated in Minnesota (Bruner and Edwards, Kentucky Agr. Exp. Sta., Bull. 431, 1912), the same type was recognized among cultures received from Massachusette, Michigan, Penney Isania, Maryland, South America and Japun. Also Isolated from German soldiers in

Norway by Tesdal (Kauffmann, Die Bakteriologie der Salmonella-Gruppe, 1941, 295) and from snakes by Hinshaw and McNeil (Amer. Jour. Vet. Res. 6, 1945. 264).

99. Salmonella sp. (Type Shangani). (Salmonella shangani Kauffmann, Acta Path. et Microbiol. Scand., 16, 1939, 347.)
Antigenie structure; III, X, XXVI: d:

1, 5. . . .

Source: Isolated in Zanzibar by Dr. J. D. Robertson from a woman with enteric fever.

Habitat: Known only from human sources as yet.

100. Salmonella sp. (Type Zanzibar). (Salmonella zanzibar Kaufmann, Acta Path, et Microbiol. Scand., 16, 1939, 347.) Antigenic structure: III, X, XXVI: k: 1, 5....

Source: Isolated in Zanzibar by Dr. J. D. Robertson from a typhoid carrier. Habitat: Also found in chickens (Edwards).

101. Salmonella sp. (Type Amager). (Salmonella amager Kauffmann, Acta Path et Microbiol Scand., 16, 1939, 347.)
Antigenic structure: III, X, XXVI; y:

1, 2, 3. . . .

Source: Isolated in Copenhagen from the feces of a person suffering from gastroenteritis

Habitat: Known only from human sources as yet.

102. Salmonella sp. (Type Lexington). (Salmonella lexington Rubin, Jour. Bact., 40, 1940, 463; Edwards, Bruner and Rubin, Proc. Soc. Exper. Biol. and Med., 44, 1940, 395.)

Antigenie structure III, X, XXVI: z<sub>10</sub>: 1, 5.

According to Kaufmann (Die Bakteriologie der Salmonella-Gruppe, 1941, 276), Dr. Erber of Java has found a Salmonella type with the same antigenic structure and has given it the name Salmonella batavia. Source: Isolated from mesenteric lymph glands of apparently normal hogs by Dr. H. L. Rubin, Univ. of Kentucky, Lexington, Ky.

Habitat: Also reported from turkeys

103. Salmonella sp. (Type Weltevreden). (Salmonella weltevreden Mertens, quoted from Kauffmann, Acta Path et Microbiol. Scand., 19, 1942, 529)

Antigenie atructure: III. X. XXVI-

r: z. . . .

Source: Isolated by Dr. W. K. Mertens, Batavía, Java, according to Kauffmann (loc. cit.).

Habitat: Not recorded in available literature.

104. Salmonella sp. (Type Orion). (Salmonella type, var. orion and Salmonella orion Barnes, Cherry and Myers, Jour. Bact. 50, 1945, 578.) From a seaman on the S. S. Orion.

Antigenic structure: III, X, XXVI.

y: 1, 5. . . . Source: From rectal swab specimen

from a normal food handler.

Habitat: Not reported from other nources as yet.

105. Salmonella sp. (Type Butantan). (Salmonella butantan Pelufio, Bier, Amaral, and Biocca, Mem. Inst. Butantan, 19, 1946, 211.)

Antigenie structure: III, X, XXVI.b

1, 5.... Source: Isolated by Dr. C. A. Pelufo from a case of diarrhoes in a child.

Habitat: Not reported from other sources as yet.

106. Salmonella sp. (Type Newington) (Anatum C, No. 3071, N.C.T.C., London, Kauffmann and Silberstein, Cent., Kauffmann and Silberstein, Cent., Bakt., I Abt., Orig., 152, 1934, 434; Salmonella newington Edwards, Jour.

Hyg., 37, 1937, 384.)
Antigenic structure: III, XV: e, h:

 Source: Isolated from ducks from Newington, Connecticut by Dr. L. F. Rettger. Also found in hogs, silver foves and man. Kauffmann (Ztschr. f. llyg., 120, 1937, 177) bas described a related type (Salmonella tim) from a case of entertits in Tim. Denmark.

Habitat Widely distributed.

107. Salmonella sp. (Type Selandia). (Salmonella selandia Kaufimann, Ztschr. f Hyg., 120, 1937, 189).

Antigenie structure: III, XV: e, h:

1, 7.

Source: Isolated from the feees of a sailor on the S S. Selandia after a voyage to Asia and Australia. Was patient in Bispeherg Hospital with pleuropneumonia at the time.

Habitat. Known only from human

sources as jet.

108 Salmonella sp. (Type New Brunswick). (Salmonella new brunsurek Edwards, Jour. Hyg, 37, 1937, 381; also see Kauffmann, Ztschr f. Hyg, 120, 1937, 189)

Antigenic structure: III, XV: I, v

Source: Isolated by Dr. I'. R. Beau-

dette, New Brunswick, New Jersey from a chicken. Also isolated from gastroenteritis in man. Habitat Apparently widely dis-

Habitat Apparently widely distributed

109 Salmonella sp. (Type Illinois) (Salmonella illinois Edwards and Bruner, Proc Soc Exper. Biol and Med., 48, 1012, 200)

Proc Sec Exper. Biol and Med , 48, 1981, 210)
Antigenic structure. (111), (XV).

XXXIV . 210. 1, 5 . .

Source Isolated from bogs in Illinois by Dr Robert Graham, from Hungarian partridges in Michigan by Mrs Virginia Stoney and from turkeys in Minnesota by Dr B. S. Pomercy

Habitat; Also reported from logs and

man (l'dwards)

110 Salmonella sp. (Type Senftenberg) (Typus Senftenberg, Kauffmann, Ztschr. f. Hyg., 111, 1930, 221; Salmonella senftenberg Schütze et al., Jour. Hyg., 54, 1934, 339; Salmonella senftenbergensis Haupt, Ergebnisse der Hyg., 15, 1932, 673.)

Antigenic structure. I, III, XIX; g, s, t: -.

Source: From a case of acute gastroenteritis in a boy in Senftenberg, Denmark. Cultures have frequently been found from persons and also from young turkeys

Habitat: Apparently widely dis-

tributed.

111. Salmonella sp. (Type Niloese). (Salmonella niloese Kauffmann, Acta patb. et Mierobiol. Scand., 16, 1939, 317)

Antigenie structure: I, III, XIX; d:

Source. Isolated in Copenhagen from a case of acute gastroenteritis in Niloese, Denmark. Later found frequently in gastroenteritis in Denmark.

Habitat: Known only from human sources as yet.

112 Salmonella sp. (Type Simsbury). (Salmonella simsbury Bruner and Edwards, Proc. Soc. Exper. Biol. and Med., 59, 1912, 174.)

Antigenie structure: I, III, XIX. zn:

Source Original culture isolated by Dr. E. K. Borman, State Dept. Health Lab., Hartford, Conn., from a normal human carrier from Sinsbury, Conn. Librards states (1916) that this may be a variant of Salmonella sp (Type Senftealerg).

Habitat Also found in turkeys (Bruner and Edwards, Kentucky Agr. Exp. Sts., Bull 434, 1912, 9).

113. Salmonella sp. (Type Taksony). (Salmonella talkony Itauss, Zischr. f. Immunit\(\frac{5}{2}\)termsch., 103, 1943, 220)

Antigenic structure, I, IIf, XIX: i.

Source Isolated from a healthy carrier (Hungary).

Habitat: Not reported from other sources as yet.

114. Salmonella sp. (Type Kentucky). (Salmonella kentucky Edwards, Jour. Hyg., 58, 1938, 306.)

Antigenic structure: (VIII), XX: i:

Source: Isolated from the intestinal tract of a chick affected with coccidiosis and ulcerative enteritis. Found at Levington Kentucky.

Habitat: Also reported from many species of fowls, from hogs and from man (Edwards).

115. Salmonella sp. (Type Aberdeen). (Salmonella aberdeen J. Smith, Jour. Hyg., 34, 1934, 357.)

Antigonic structure: XI:1: 1, 2, 3. . . . . Source: Isolated in Aberdeen, Seotland, from the stool of a child suffering from acute enteritis. Also isolated by Tramerman in Utreeht from Ovomaltine, and by Edwards in Kentucky from birds Seo Kauffmann, Die Bakteriologie der Salmonella-Gruppe, Kopenhagen, 1911, 279.

Habitat: Apparently widely distributed.

116. Salmonella sp. (Type Rubislaw). (Salmonella rubislaw Smith and Kauffmann, Jour. Hyg., 40, 1940, 122.)

Antigenic structure: IX:r:c,n,x...

Source: Isolated in Aberdeen, Scotland from the feces of a child suffering from enteritis Also found by Tesdal in Osfo, Norway. Reported by Hinshaw and McNet! from snakes (AmerJour. Vet Res, 6, 1945, 264).

Habitat Apparently widely distributed.

117. Salmonella sp. (Type Pretoria) (Salmonella pretoria Henning, Rhodes and Gordon-Johnstone, Onderstepoort Jour. Vet. Sci An. Ind., 16, 1911, 103.)
Antigenie structure: X1: k: 1, 2, 3....

Source: Isolated by Dr. M. W. Henning in Pretoria, South Africa from an infection in garbage-fed bogs.

Habitat: Not reported from other sources as yet.

118. Salmonella sp. (Type Venezis). (Salmonella veneziana Bruner and Joyce, Jour. Bact., 50, 1915, 371.)

Antigonie structuro: XI: i: e, n, x.... Source: Culture received from Capt J. K. Hill. Isolated from an apparently normal Italian civilian food handler in Venice, Italy.

Habitat: Not known from other sources as yet.

119. Salmonella sp. (Type Solt). (Sd. monella solt Rauss, Ztschr. f. Immunitātsforsch., 103, 1943, 220.)

Antigenic structure: XI: y: 1, 5.... Source: Isolated from a healthy carrier (Hungary).

Habitat: Not reported from other sources as yet.

120. Salmonella sp. (Typo St. Lucie) (Salmonella luciana Moran, Edwards and Bruner, Proc. Soc. Exp. Biol. and Med, 64, 1917, 89.) From St. Lucie, Florida-Antigonic structure: XI: a: e, n,

Source: Single culture isolated by Mrs Mildred Galton from feces of a normal

human carrier. Habitat: Not known from other

equirees as yet.

121. Salmonella sp. (Type Senegal)
(Salmonella senegal Hinshaw and

MeNeil, Jour. Bact., 52, 1916, 349)
Antigeme structure: XI: r: 1, 5...
Source: Isolated by Dr. W. L. Han-

shaw from a green mamba snake
Hsbitat: Not known from other
sources as yet.

122. Salmonella sp. (Type Marseille). (Salmonella marseille Moran, Edwards and Bruner, Proc. Soc. Exp. Biol. and Med., 64, 1947, 89.)

Antigenic structure: XI: a: 1, 5...
Source: Isolated in Marseilles, France
by Capt. Wm. Sutton from feces.

Habitat: Not known from other sources as yet.

123. Salmonella sp. (Type Grumpy). (Salmonella grumpensıs Hormacche and Peluffo, quoted from Hormacche et al., Jour Bact, 47, 1914, 323.) Named for a person called grumpy.

Antigenic structure: XIII, XXIII, XXXIII, XXXVI: d·1, 7... as given by Kauffmann (Acta Path. et Microbiol Seand., Suppl. 51, 1914, 37).

Source. Isolated in Uruguay Irom a gunca pig. Also studied by Kauffmann (loc cit)

Habitat: Not reported from other sources as yet.

121. Salmonella sp. (Type Poona) (Salmonella poona Bridges and Scott, Jour Roy Army Med Corps, \$5, 1935,

Antigenic structure, XIII, XXII z.

1, 6 .
Source: Isolated by Dr. L. Dunbar in Poona from the stool of a child suffering

from enteritis

Habitat: Also reported from hogs
(Edwards).

125 Salmonella sp. (Type Borbeek). (Salmonella borbeek Holm and Hernmann, Cent. f. Bakt., I Abt , Orig , 145, 1040, 219.)

Antigenic structure XIII, XXII: I, v 1, 6. . .

Source I solated from the feces of a child with typhoid. Found in the Borbeck section of Essen, Germany. Habitat: Not reported from other

sources as yet.

126 Salmonella sp. (Type Mississippi).

(Salmonella mississippi Edwards, Cherry and Bruner, Proc. Soc. Exp. Biol. and Med., 54, 1943, 263.)

Antigenie structure: I, XIII, XXIII, b: I, 5 . . . Source: Isolated by the State Dept. of Health of Mississippi from the stool of a normal lood handler.

Habitat: Also reported from hogs (Edwards).

127. Salmonella sp. (Type Wichita). (Salmonella wichila Schiff and Strauss, Jour. Inf. Dis., 65, 1939, 125.)

Antigenic structure: 1, XIII, XXIII:

Source Isolated by Miss B. McKinlay in an epidemic of enteritis affecting babics, Wichita, Kansas Also in fowls, turkeys and hogs (Edwards and Bruner, Jour, Inf. Dis., 72, 1942, 61).

Habitat: Apparently widely dis

mouted.

128. Salmonella sp. (Type Havana). (Salmonella harana Schiff and Saphra, Jour. Inf. Dis., 68, 1941, 125.)

Antigenic structure: I, XIII, XXIII: f, g: -.

Source: Isolated during an outbreak of 21 cases of meningitis in children in a maternity hospital in Hayana, Cuba.

Habitat: Not reported from other sources as yet.

I29. Salmonella sp. (Type Worthington). (Salmonella worthington Edwards and Bruner, Jour. Hyg, 33, 1933, 716.) Antigenie structure: I, XIII, XXIII: I, W. Z....

Source: Isolated by Dr. B. S. Pomeroy from a turkey poult from Worthington, Minnesota. Also found in a hen. Later additional cultures were found in other hirds, in rodents, cattle, hogs and man. (Edwards and Bruner, Jour. Inf. Dis., 72, 1913, 61).

Habitat: Apparently widely distributed.

130 Salmonella up. (Type Cuba). (Salmonella cubana Seligmann, Wasserman and Saphra, Jour. Bact., 81, 1916, 123)

Antigenic structure: I, XIII, XXIII:

Source: Isolated in Havana, Cuba by Dr. Arturo Curbelo from diseased baby chicks.

Habitat: Not reported from other sources as yet.

131. Salmonella sp. (Type Heves). (Salmonella heres Rauss, Ztschr. f. Immunitätsforsch., 103, 1943, 220.)

Antigenic structure: VI, XIV, XXIV:

Source: Isolated from a healthy carrier (Hungary).

Habitat: Not reported from other sources as yet.

132. Salmonella sp. (Type Carrau). (Salmonella carrou Hormacehe, Peluffo and Salsamendi, Arch. Urug. de Med., Cirug. y Espec., 12, 1938, 377; Hormacche, Peluffo and Pereyra, Jour. Bact., 47, 1944, 323.)

Antigenic structure: VI, XIV, XXIV: y: 1, 7, . . .

Source: Isolated in Uruguay from mesenteric glands of normal hogs.

Habitat: Also reported from feees and blood in man, once from flies and one culture from buman blood from Mexico.

133 Salmonella sp. (Type Onderstepoort). (Salmonella onderstepoort Henning, Jour. Hyg., 56, 1936, 525.)

Antigenie structure: (I), VI, XIV, XXV: e, (h) 1, 5 ...

Source: Isolated in So. Africa by Dr.
J. H. Mason from sheep in Onderstepoort. Also isolated from man by Dr.
Hormacche (Uruguay) and from turkeys
(Edwards, Kentucky)

Habitat Apparently widely distributed in warm-blooded animals

134 Salmonella sp. (Type Florida). (Salmonella florida Cherry, Edwards and Bruner, Proc. Soc. Exp. Biol and Med., 52, 1943, 125; Galton and Quan, Amer. Jour. Hyg., \$8, 1943, 173.)

Antigenic structure. (I), VI, XIV, XXV: d. 1, 7. . . .

Source: Isolated by Mrs. Mildred Galton from feecs of a patient with a febrile disease and diarrhoea

Habitat: Also reported from reptiles (Edwards).

135. Salmonella sp. (Type Madelia). (Salmonella madelia Cherry, Edwards and Bruner, Proc. Soc. Exp. Biol. and Med., 52, 1943, 125.)

Antigenic structure. (I), VI, XIV, XXV: y: 1, 7....

Source: A single culture isolated by Dr. B. S. Pomeroy from the liver of a poult that died of septicemia. Found in Madelia, Minnesota.

Habitat: Also reported from man (Edwards).

136. Salmonella sp. (Type Sundsvall) (Salmonella sundsvall Olin and Alin, Acts Path. et Microbiol. Scand, 29, 1943, 607.)

Antigenie structure: (I), VI, XIV,

XXV: z: e, n, x....

Source: Isolated from a person suffer ing from gastroenteritis.

Habitat: Not reported from other sources as yet.

137. Salmonella sp. (Type Orient) (Salmonella orientalis Carlquist and Conte, Bull. U. S. Array Med. Dept, 6, 1916, 343.)

Antigenie structure: XVI· k: e, n,

Source: Isolated from U. S. Army personnel who had been prisoners of the Japanese Army in the Orient.

Habitat: Not known from other sources as yet.

133 Salmonella sp. (Type Hviting foss). (Salmonella hvittingfoss Tesdal, Ztschr. f. Hyg., 118, 1936, 533)

Antigenic structure: XVI. b: e, n,

Source: Isolated during a food poisoning outbreak in Hvittingfoss, a small town in Norway. Caused by eating

pultoste, a kind of soft cheese. Cultures secured from the cheese, from the persons who were poisoned, from sewage and from a foal.

Habitat: Evidently rather widely

distributed.

139. Salmonella sp. (Type Gaminara). (Salmonella gaminara Hormaeche, Peluffo and Salsamendi, Arch. Urug. do Med., Cirug. y Espec., 12, 1938, 377; whid., 14, 1939, 217.) Named in honor of

Prof. Gaminara of Uruguay.

Antigenic structure: XVI; d: 1,7....

Source: Isolated from the feces of a

child suffering from enteritis. Habitat: Not known from other

sources as yet.

140. Salmonella sp. (Type Szentes).
(Salmonella szentes Rauss, Ztschr. f.

(Salmonella szenies Rauss, Ztschr. f. Immunitätsforsch., 103, 1943, 220) Antigenie structure: XVI: k: I, 2,

Source: Isolated by Dr. K. Rauss

from a healthy earrier (Hungary).

Habitat: Not reported from other sources as yet.

141. Salmonella sp. (Type Kirkee). (Salmonella kirkee Bridges and Dunbar, Jour. Roy. Army Med. Corps, 67, 1936, 282.)

Antigenic structure: XVII: b: 1,2.... Source: Isolated in Kirkee, India from the feces of a child suffering from acute enteritis. The source of the infection was thought to be a dog.

Habitat: Not reported from other sources as yet.

142. Salmonella sp. (Type Cerro). (Bacterium cerro Hormaeche, Pelufic and Salsanendi, Arch. Urug. McL., Cirug. y Espec., 12, 1938, 377; Salmonella cerro Hormaeche, Pelufic and Aleppo, 1964, 19, 1941, 125)

Antigenic structure: XVIII: 24, 22,

Source: Isolated from the mesenteric glands of normal hogs from Cerro, Urugusy. Habitat: Also isolated by the authors in 13 cases of infantile infections. Found also in chickens (Edwards).

143. Salmonells sp. (Type Minnesota). (Salmonella minnesota Edwards and Bruner, Jour. Hyg., 38, 1938, 716.)

Antigenie structure: XXI, XXVI:

b: e, n, x. . . .

Source: Isolated in Minnesota by Dr. B. S. Pomeroy from a young turkey. Habitat. Also reported from cattle

and man.

144. Selmonells sp. (Type Tel Aviv). (Salmonella tel-griv Kauffmann, Acta Path. et Microbiol. Scand., 17, 1940, 1.) Antigenic atructure: XXVIII: y: c,

n, z<sub>11</sub>

Source: Isolsted in Tel Aviv, Palestine
by Dr. G. B. Simmins during an epizootic affecting young chickens during
which 50 per cent died.

Habitat; Not known from other sources as yet

145. Salmonella sp. (Type Pomona). (Salmonella pomona Edwards, Proc. Soc. Exp. Biol. and Med., 58, 1945, 291.)

Antigenic structure: XXVIII: y: 1,

Source: Single culture isolated from the intestine of a poult in 1941 by Dr. W. R. Hinshaw.

Habitat: Also reported from man (Edwards).

146. Salmonella sp. (Type Ballerup), (Salmonella ballerup Kauffmann and Møller, Jour. 11yg., 40, 1940, 246.)

Antigenic structure XXIX, [Vi]:

Source: From the feces of a woman from the town of Ballerup, Denmark. A cause of gastroenteritis

Habitat: Not known from other sources as yet.

147. Salmonella sp. (Type Hormacche). (Salmonella hormaechei Monteverde, Nature, 154, 1911, 676) Named in honor of Dr. Hormaeche of Uruguay. Antigenic structure: XXIX, [Vi]\*:  $z_{30}$ ,  $[z_{21}]$ : —.

Source: From the ovary of a hen whose blood gave a positive reaction with the S. pullorum antigen. Found in Buenos Aires by Dr. Monteverde.

Habitat: Also reported from hogs and man (Edwards).

\*Reported by Dr. P. R. Edwards (personal communication).

148 Salmonells sp. (Type Urbana). (Salmonella urbana Edwards and Bruner, Jour. Inf. Dis., 69, 1941, 223.)

Antigenic structure. XXX; b: e, n,

Source: One culture was received from Dr. Robert Graham, Urbana, Illinois and was isolated from the contents of the colon of a bog affected with hemorrhagic enteritis. The second culture was isolated from the intestinal tract of a chicken by Dr. W. L. Mallmann, East Lansing, Michigan

Habitat: Also reported from man (Edwards)

149 Salmonella sp. (Type Adelaide). (Salmonella adeloide Cleland, Med. Jour. Australia, \$1, 1944, 59)

Antigenic structure XXXV: f, g: -.
Source Isolated in Adelaide, Australia
by Miss Nancy Atkinson from two fatal
cases resembling typhoid fever.

Habitat Not reported from other sources as yet

150 Salmonella sp. (Type Inverness). (Salmonella inverness Edwards and Hughes, Proc Soc Exp Biol and Med, 56, 1944, 33)

Antigenic structure XXXVIII: k

Source · Isolated by Mrs. Mildred Galton and Mr M. S. Quan of the Florida State Department of Health, frem the stool of a normal food handler, Inverness, Florida.

Habitat Not reported from other sources as yet

151. Salmonella sp. (Type Champaign) (Salmonella champaign Ed-

wards, Proc. Soc. Exp. Biol. and Med, 58, 1945, 291.)

Antigenic structure: XXXIX: 1
1,5....

Source: Single culture isolated from the liver of an adult hen by Dr. Robert Graham, Champaign, Illinois.

Habitat: Not reported from other sources as yet.

Appendix I: The following species and varieties are largely taken from Hauth roy, Ehringer, Urbain, Guillot and Magrou, Dictionnaire des Esctéris Pathogènes, Paris, 1937, 446-472. The relationships of many of these are an elegar.

Bacillus canoriensis Miguls. (Bacillus der Kanarienvögelseptikame). Rieck, Deutsche Zischr. f. Thiermed, 15, 1889, 69; Migula, Syst. d. Bakt., f. 1900, 770; Bacillus avisepticus Chestr., Man. Determ. Bact., 1901, 220, not Becillus prisepticus Kitt, in Kolle saf Wassermann, Handb. d., path. Milvoog. I Aufl., 2, 1903, 544.) Associated sub intestinal cotarrh and liver changes in canaries. Hadley, Elikas sad Caldwell (Rhode Island Agr. Exp. Sta. Bull 14, 1918, 178) regard this as probably Bactlus gallinarum Klein.

Bacillus friedebergensis Kruse (Scillus der Friedeberger Felsehnerstung, Gaffky and Paak, Mitt. a. & kaiserl. Gesundheitsamte, 6, 1890, 189, Kruse, in Flugge, Die Mikroorganisme, 3 Aufl. g., 1896, 378; Bacterium Inclebergensis Chester, Ann. Rept. Del. Cd Agr. Exp. Sta., 9, 1897, 73) From sausage in meat poisoning.

Salmonella abortus canis Gard. (Zisch. f. Hyg., 121, 1933, 139.) From the fixes of four persons with paratyphoid apparently spread from an infected destaultman regards this as identical with Salmonella schottmuelleri.

Salmonsilla annamensis Hauduroy et sl. (Un bacille du groupe des Salmondis, Normet, Urbain and Chaillot, Corps. rend. Soc. Biol., Paris, 101, 1929, 73, Hauduroy et al., Diet. d. Bact. Path, 1937, 450 ) Isolated during an epidemic of dysentery at Hué (Annam) in 1925 Salmonella archibaldu Castellani and

Chalmers. (Man. Trop. Med , 3rd ed., 1919, 940 )

Salmonella carolina (Castellani) Castellani and Chalmers. (Bacıllus carolinus Castellani, Ann di Med. Nav. e Colon., 1, 1918; Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 940.)

Salmonella caagulans (Castellani) Ilauduroy et al. (Bacillus coagulans Castellanı, 1916, Balkanella coagulans Castellanı, 1916; see Castellanı and Chalmers, Man. Trop. Med., 3rd ed., 1919, 935: Hauduroy et al., Diet d. Baet.

Path., 1937, 453)

Salmonella columbensis (Castellani) Castellani and Chalmers. (Bacterium columbense Castellani, Proc. Meeting Ceylon Branch British Assoc., 1905, quoted from Castellani, Cent. f Bakt., I Abt., Orig., 74, 1914, 197; Bacellus columbensis Castellani, Jour. Trop Med and Hyg , 20, 1917, 181; Castellani and Chalmers, Ann. Inst. Past., 34, 1920, 609; Morganella columbensis Fulton, Jour. Bact., 46, 1913, 81 ) The cause of columbensis fever. Isolated from feces, urine and blood.

Salmonella enteritidis var. v, Hauduroy et al. (Bacille para-Gartner V. Rochaix and Couture, Revue de Mierobiologie appliquée, 2, 1936; Hauduroy et al., Diet. d. Bact, Path., 1937, 454.) l'ound associated with Salmonella enterifidis in meat pies and in the leees of andaviduals with Icoal poisoning

Salmonella enteritidis y ellow, a variety ed Salmonella enteretidis Deskowitz and Buchbinder (Jour. Baet., 29, 1935, 293). Cultures differ from typical Salmonella enteritidis in producing a yellow, watersoluble pigment. From the leves of a rat with enteric infection.

Salmonella foetida Bergey et al. (Coccobacillus foetidus ozenae Perez, Ann. Inst. Past., 13, 1879, 937; Coccobacillus (foetidus) ozaenae Ward, Jour. Bact., 2, 1917, 619; Bergey et al., Manual, 1st ed , 1923, 220, Bacterium foetida Weldin and Levine, Abst. Bact., 7, 1923, 13; Escherichia factida Bergey et al . Manual. 2nd ed., 1925, 222 ) From chronic rhinitis, ozena. See Manual, 4th ed., 1931, 380 for a description of this species.

Salmonella holsationsis (Also Salmanella Typ Holstein, Roelcke, Cent. f Bakt., I Abt., Orig., 137, 1936, 461.) According to Kauffmann (Ztschr. f. Hyg., 119, 1937, 352) the O-antigens of this rapid fermenter of salicin and weak indole-former are identical with those of Salmonella poona. The II-antigens have not been compared as yet.

Salmonella icteroides (Sanarelli) Bergey et al. (Bacillo icteroide, Sanarelli, Il Polichnico, 4, 1897, 412; Bacillus icteroides Sanarelli, British Med. Jour., July 3, 1897, 7; Bacterium icteroides Lehmann and Neumann, Bakt. Diag., 2 Aufl , 2, IS99, 211; Bergey et al , Manual, 1st ed., 1923, 218) From yellow fever endavers. See Manual, 5th ed., 1939, 601 for a description of this anceies

Salmonella 120-juna Lindberg and Bayless. (Jour. 1nf. Dis., 79, 1916, 92.) Isolated from a soldier on Iwo-Jima during a routine examination of food handlers. Belongs to Group C. Antigenie structure: VI, VIII: i: 1,5 . . . Described too recently to be included in the main body of the text.

Salmonella liceagi Leon. (Rev. Inst. Salubridad y Enferm. Trop , 3, 1912, 273 ) From feces. This probably belongs in the coliform group.

Salmonella macfadyeanii (Weldin and Levine) Weldin. (Bacterium macfad. weams Weldin and Levine, Abst. Bact . 7, 1923, 13; Weldm, Iowa State Jour Ser. 1, 1927, IGS) Associated with high cholera.

Salmanella mexicona Varela and Olarte. (Rev. Inst. Sulubridad y Linferm. Trop , 4, 1913, 313.) 1 rom leces

Salmonella monthaui Carloust and Costes (Jour. Bact., 55, 1917, 2(9) leolated from stump of a solder who suffered traumatic amputation of a leg In the fighting around Monshau, Germany. Belongs to Group F. Antigenic structure: XXXV: m. t.:—Described too recently to be included in the main body of the text.

Salmonella nocardi Pacheco. (Compt. rend. Soe Biol., Paris, 106, 1931, 372 and 1018.) Pathogenie for parrots and pigeons.

Salmonella oahu Lindberg and Bayliss. (Jour. Inf Dis., 79, 1946, 92.) Isolated from a case of gastroenteritis in a soldier hospitalized on Oahu. Belongs to Group B. Antigenie structure: IV, V, XII: 1, v: 1, 2, 3... Described too recently to be included in the main body of the text.

Salmonella ostrei (Besson and Ehringer) Hauduroy et al. (Bacillus ostrei Besson and Ehringer, Compt. rend. Soc. Biol., Paris, 87, 1922, 1017; Hauduroy et al., Diet. d. Bact. Path., 1937, 460.) Isolated from oysters. Not pathogenic for laboratory animals.

Salmonella para-asiatica (Castellani) Hauduroy et al. (Bacillus paraasiaticus Castellani, 1916; see Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 950; Hauduroy et al., Diet. d. Bact Path, 1937, 461)

Salmonella para-coagulans (Castellani) Hauduroy et al (Bacillus para-coagulans Castellani, 1914; see Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1909, 1950; Hauduroy et al., Diet. d. Baet Path., 1937, 461.)

Salmonella pauloensis Gomes. (Rev. Inst. Adolfo Lutz, 2, 1942, 231.) May be the same as Salmonella columbensis.

Salmonella pseudo-asiatica (Castellani) Castellani and Chalmers. (Bacillus pseudo-asiaticus Castellani, Cent. f. Bakt, I Abt, Orig., 65, 1912, 265; Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 940.)

Salmonella pseudo-assatica var. mobilis Hauduroy et al. (Bacillus pseudoasiaticus mobilis Castellani, sec Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 952; Hauduroy et al., Dict. d. Bact. Path., 1937, 463.)

Salmonella (?) pseudo-carolina (Cas-

tellani) Hauduroy et al. (Bacillus pres docarolinus Castellani, 1917; see Castellani and Chalmers, Man. Trop. Med, 3rd ed., 1919, 952; Hauduroy et al, Dict d. Bact. Path., 1937, 463.)

Salmonella (1) pseudo-columbens: (Satellani) Hauduroy et al. (Bacilia pseudo-columbensis Castellani, see Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 954; Hauduroy et al, Diet. d. Baet. Path., 1937, 464.)

Salmonella pseudo-morganii (Castellani) Hauduroy et al. (Bacillus pseudomorgani Castellani, see Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 954; Hauduroy et al., Diet. d Baet. Peth. 1937, 464.)

Salmonella ranicida Hauduroy et al (Bacille pathogène isoló des genouniles, Cheorghiu and Balmus, Compt. rad Soc. Biol., Paris, 108, 1931, 1002; Hauduroy et al., Dict. d. Bact. Path., 189, 466.) Pathogenic for frogs.

Salmonella sarpan Lindberg and Bay liss. (Jour. Inf. Dis., 79, 1946, 2) Isolated from a case of gastroenteritis in a soldier hospitalized on Suban Belongs to Group E. Antigenic structure: III, X, XXVI: z... Described too recently to be included in the min body of the text.

Salmonella schottmülleri var. akri Hauduroy et al. (Bacillus pratiphi aleci Bahr, Skand. Veterin. Tüdk. // 1919; Hauduroy et al., Dict. d. Bat Path., 1937, 469.) Pathogenie for bes and wasps.

Salmonella veboda (Castellani) Castellani and Chalmers. (Bacullus rebos Castellani, Jour. Trop., Med. and Ilya Op. 1917, 181; Castellani and Chalmer Man. Trop. Med., 3rd ed., 1919, 38 Bacterium reboda Weldin and Leviu Abst. Bact., 7, 1923, 13.)

Salmonella watareka (Castellani) Bet gey et al. (Bacillus watareka Castellan Rept. Advisory Committee for Troj Dis. Research Fund for 1912, London 1913; Bacterium watareka Weldin an Levine, Abst. Bact., 7, 1923, 13; Berge et al., Manual, 1st ed., 1923, 219) Salmonella ucrahensis (Castellani) Huduroy et al. (Bacillus werahensis Castellanu, seo Castellani and Chalmers, Man Trop. Med., 3rd ed., 1919, 956, Hauduroy et al., Diet. d. Bact Path., 1937, 471.)

Salmonella vesembergoides (Castellam) Hauduroy et al. (Bacillus vesembergoides Castellani, 1916, see Castellani and Chalmers, Man Trop Med, 3rd ed., 1913, 935; Hauduroy et al., Diet d Bact Path, 1937, 471.)

Salmonella uillegoda (Castellani) Castellani and Chalmers (Bacillus willegoda Castellani; Castellani and Chalmers, Man. Trop Med., 3rd ed., 1919, 979)

Salmonella voliniae (Castellanı) Castellanı and Chalmers. (Bucultus voliniae Castellani, Jour. Trop. Med. and Hyg., 29, 1917, 181; Castellanı and Chalmers, Man. Trop. Med., 3rd. ed., 1919, 939; Bacterium vediniae Weldin and Levine, Abst. Bact. 7, 1923, 13)

Appendix II: The following species have been thought to belong to the genus Ebethella, i.e., do not produce gus from glucose Descriptions of nearly all of the species listed in the genus Ebethella will be found in the Manual, site of 1933, 461-469.

Bacillus subentericus Ford (Studies from the Royal Victoria Hosp, Montreal, I, 1903, 40; also see Jour Med Res. I, 1901, 218) From feces

Bacterium tiphi, faitim Dreed and Stiekl (Deutsche med. Weinschr. 54, 1925, 517.) From feers of persons with typhoid fever. Crunckshank (Jour Hyg. 35, 1933, 55) preports that a variety of yellow chromogenic exprophytes have been identified as belonging to this species, none of which could be regarded as yellow varients of Salmonella typhoia (Zoph) White. They apparently belong in the genus Florobacterium Bergey et al.

Lberthella alcalifaciens de Salles. Goines (llivista do Inst Adolfo Lutz, 4, 1944, 191.) From catarrhal feces of an infant.

Eberthella belfastiensis (Weldin and Levine) Bergey et al. (Bacterium coli anaerogenes Lembke, Arch. f. Hyg., 26, 1896, 299, Bacterium lembles Migula. Syst. d. Bakt., 2, 1900, 417; Bacterium anaerogenes Chester, Man Determ. Bact., 1901, 135. Bacıllus belfastiensis II. Wilson, Jour. Hyg., 8, 1908, 513; Bacillus anaerogenes Holland, Jour. Bact., 5, 1920, 217; Bacterium belfastionsis Weldin and Levine, Abst Bact., 7, 1923, 13, Bergey et al Manual, 1st ed 1923, 226; Bacillus coli anderogenes Kerrin, Jour. Hyg., 23, 1928, 4; Escherichia anaerogenes Bergey et al., Manual, 3rd ed., 1930, 321; Castellanus colianaerogenes Castellani, Cent f. Bakt., I Abt , Orig , 125, 1932, 42.) From feces

Eberhella Lentelensus (Castellani and Chailmers) Regey et al. (Baellus bentictensus Castellani, Cent. f. Bakt., I. Abt., Orig., 63, 1912, 2622, Baeterium bentietensus Weldin and Levine, Abet. Baet., 7, 1023, 15; Bergey et al., Manual, 1st. ed., 1023, 227, Castellanus bentietensus Castellani, Cent. f. Bakt., I. Abt., Orig., 125, 1032, 42). From the intestinal ennal

Eberthella chylogena (Ford) Bergey et al. (Racillus chylogenes Ford, Studies from the Royal Victoria Hospital, Montreal, I, No. 5, 1903, 62; Bergey et al., Manural, 1st ed., 1923, 221) From the intestinal canal

Eberbella duba (Chester) Bergey et al (Menner Bakterne, Bleisch, Ziedir, f. Hyg., 13, 181), 31; Bacellus dubus Kruse, in Flügge, Die Mikroorganismen, 3-Mill. g., 1903, 323; Bacellus bleischu Kruse, ibid., 701; Bacterium dubus Chester, Ann. Rept. Del. Cal. Agr. Exp. Sta., 9, 1807, 93; Horgey et al., Manual, 1st. ed., 1923, 225.) From the intestinal canal.

Eberthella enterica (Ford) Bergey et al. (Hacillus entericus Ford, Studies from the Royal Victoria Hospital, Montreal, 1, No. 5, 1900, 40; also see Jour. Med. Research, 1, 1901, 211; not Bacillus entericus Castellani, 1907 (Enteroides entericus Castellani and Chalmera, Man. Trop. Med., 3rd ed., 1919, 911); Bergey et al., Manual, 1st ed., 1923, 223.) From the intestinal eanal.

Eberthella insecticola Steinhaua. (Jour. Baet., 42, 1941, 762 and 769.) From the intestinal tracts of grasshoppers, milkweed bugs and stinkbugs.

Eberthella kandiensis (Castellani) Bergey et al. (Bacillus kandiensis Castellani, Cent. f. Bakt., I Abt., Orig., 65, 1912, 262; Eberthus kandiensis Castellani and Chalmers, Man. Trop Med., 3rd ed., 1919, 936; Bacterium kandiensis Weldin and Levine, Abst. Bact., 7, 1923, 13; Bergey et al., Manual, 1st ed., 1923, 225.) From feees.

Eberthella lewisti Weldin. (Organism B3t, Lewis, Local Gov. Board Rept. Med. Suppl. London, 1910-11, Appen. B, No. 2, 1911, 314; Bactersum lewisti Weldin and Levine, Bact. Abst. 7, 1923, 13; Weldin, Iowa State Col. Jour Sci. 1, 1926, 172.) From feces of a normal child.

Eberthella oedematiens Assis (Boletin do Inst. Vital, Brazil, δ, 1928) From

the intestinal canal.

Eberthella ozyphila (Ford) Bergey et al. (Bacterium ozyphilum Ford, Studies from the Royal Victoria Hospital, Montreal, I, No. 5, 1903, 49; Bergey et al., Manual, 1st ed., 1923, 224) From the intestinal canal.

Eberthella pauloensis Mello. (Jornal dos Clinicos, Rio de Janciro, No. 18-30, Sept., 1937, 7 pp.) From feces of a

dysentery patient.

Eberthella prizintizi (Castellani and Chalmers) Hauduroy et al. (Bacillan) prizintizi Castellani, Jour. Trop. Med. and Hyg., 20, 1917, 182; Eberthus prizintizi Castellani and Chalmers, Man Trop. Med, 3rd ed., 1919, 936; Bacterium prizintizi Weldin and Levine, Abst. Bact., 7, 1923, 13, Hauduroy et al., Dict. d. Bact. Path., 1937, 186.) From cases of paraenteric fever.

Eberthella proteosimilis Wassilien

(Cent. f. Bakt., I Abt., Orig., 151, 1944, 423.) Colonies show motility on agar. From feces of a dysentery patient.

Eberthella pyogenes (Migula) Bergey et al. (Bacillus pyogenes foetidus Passet, Fortschr. der Med., 1885; Bacillus foetidus Trevisan, I generi e le specie delle Batteriacee, 1889, 16; Bacterium pyogenes foetidus Chester, Ann Rept Del. Col. Agr. Exp. Sta., 9, 1897, 141, Bacterium puogenes Migula, Syst. der Bakt., 2, 1900, 381; Lankoides pyogenes Castellani and Chalmers, Man. Trop Med., 3rd ed., 1919, 938; Bacillus pyogenes-foetidus Holland, Jour. Bact , 5, 1920, 220; Bergey et al., Manual, 1st ed, 1923, 226; Castellanus pyogenes Castellani, Cent. f. Bakt., I Abt., Orig., 125, 1932, 42.) From a rectal abscess.

Eberthella talarensis (Castellani) Bergey et al. (Bacillus talarensis Castellani, Cent. f. Bakt., I Abt., Ong. 63. 1912, 202; Eberthus talarensis Castellani and Chalmers, Man. Trop. Med., 3d. ed., 1919, 903; Bacterium talarensis Weldin and Levine, Abst. Bact., 7, 1923, 13; Bergey et al., Manual, 1st ed., 1923, 225.) From the intestinal canal

Eberthella tarda Assis. (Boletin do Inst. Vital, Brazil, δ, 1928.) From the

intestinal canal.

Eberthella wesenbergi (Castellani and Chalmers) Hauduroy et al. (Baeiler wesenberg Castellani, 1913; Ifesenbergi wesenbergi Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 90, Hauduroy et al., Diet. d. Baet. Path. 1937, 1911.)

Eberthelta wilsonii Weldin. (Bacillus belfastiensis V, Wilson, Jour. Hys. 8, 1903, 543; Weldin, Iowa State Col. Jour Sci., 1, 1926, 174.) From feces.

Eberthella xenopa Schrire. (Trans Royal Soc. So. Africa, 17, 1928, 43) From wound infection in frogs.

Wesenbergus fermenlosus Castellani and Chalmers. (Man. Trop. Med., 3rd ed., 1919, 940.) From blood Isolated by Archibald in the Anglo-Egyptian Sudan

#### Genus II. Shigella Castellani and Chalmers.\*

(Castellani and Chalmers, Man Trop. Med., 3rd ed., 1919, 936; subgenera, Flexnerella and Shigella, Castellani and Chalmers, thid . 938, Castellanus Carruti, Jour. Trop. Med and Hyg., July 15, 1930, Proshigella Borman, Stuart and Wheeler, Jour. Bact., 48, 1944, 363 ) Named for Prof. I. Shiga, the Jananese bacteriologist who discovered the dysentery bacillus in 1898

Non-motile rods, although cultures of some of the less well-known species have been reported as motile. Produce acid but no gas from earbohydrates except with some types of Shigella paradysenterine Do not liquely gelatin. Some species produce acid from lactose and form indole Some species reduce trimethylamine oxide to trimethylamine, others do not † Some species will grow at 45 5°C (Elikman test) ‡ Pathogenic (causing dysenteries) or non-pathogenic species, all living in the bodies of narm-blooded animals. Carried by polluted water supplies and by flies.

The type species is Shinella disenterine (Shiga) Castellani and Chalmers.

## Ken to the species of genus Shizella. \*\*

- I. No said from mannitol.
  - A. No acid from lactose. Milk not coagulated.
    - 1. Indole not produced.
      - a. Acid but no gas from glucose.
        - 1. Shigella dysenteriae. as Acid and a small amount of gas from glucose.
          - 4a. See Shinella paradusenteriae (Type Newcastle).
      - 2. Indole produced

- 2. Shigella ambigua.
- B. Acid formed slowly from lactose. I Indole not produced
  - 3. Shigella gintottensis.
- 11. Acid from mannifol (one type produces a small amount of gas). A No acid from lactose
  - - I No acid from thamnose, xylose or dulcitol.
    - 4. Shigella paradysenteriae. 2 Acid from rhamnose, vylose and dulcitol,
      - 5. Shigella alkalescens.
    - 3. Acid from tylose but not from dulcitol.
      - 6. Shigella pfaffii.
    - B. Acid formed slowly from lactore. 1. Indole not produced
      - Acid from rhamnose None from xyluse.
      - 7. Shigella sonnei. aa. No acid from rhamnose Acid from xylose
- 8 Shinella equirulis.
- . Completely revised by Dr. Frederick Smith, McGill University, Montreal, P. Q., Canada, December, 1938; further revision, April, 1916.
  - t Wood, Baird and Keeping, Jour. Bact , 46, 1913, 105
  - ! Stuart and Rustigian, Jour. Bact., 49, 1913, 103 " See West, Jour In-munology, 55, 1917, 363-105

- 2. Indole produced.
  - Acid from dulcitol.
- aa. No acid from dulcitol.
- III. Action on mannitol unknown.
  A. No acid from lactose.
  - 1. Indole is produced.

- 9. Shigella ceylonensis.
- 10. Shigella madampensis.
- 11. Shigella septicemae

 Shigella dysenteriae (Shiga) Castellani and Chalmers. (Bacillus of Japanese dysentery, Shiga, Cent. f. Bakt., I Abt., 23, 1898, 599; Bacillus dysenteriae Shiga, Cent. f. Bakt., I Abt., 24, 1898, 817; Bacıllus japanıcus Migula, Syst. d. Bakt., 2, 1900, 755; Bacillus shigae Chester, Man. Determ. Bact., 1901, 228; Bacillus dysentericus Ruffer and Willmore, Brit. Med. Jour., 2, 1909, 862; Bacterium dysenteriae Lehmann and Neumann, Bakt. Diag., 5 Aufl., 2, 1912, 348; not Bacterium dysenteriae Chester, Man. Determ. Bact., 1901, 145; Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 935; Bacterium shigae Holland, Jour. Baet , 5, 1920, 220; Eberthella dysenteriae Bergey et al., Manual, 2nd ed , 1925, 250 ) Latinized, of dysentery. Rods 0.4 to 0.6 by 1.0 to 3.0 microns,

Rods 0.4 to 0.6 by 1.0 to 3.0 microns, occurring singly. Non-motile. Gramnegative.

Gelatin colonics: Small, grayish, smooth, homogeneous, entire to slightly undulate.

Gelatin stab Grayish surface growth. No liquefaction.

Agar slant. Grayish, fillform to echinulate, smooth, entire to undulate growth. Broth: Slightly turbid, with grayish sediment.

Litmus milk: Slightly acid, then alkaline.

line.
Potato. Delicate, grayish to slightly brownish streak.

Indole not produced.

Nitrites produced from nitrates.

Acid but no gas from glucose, fruetose, raffinose, glycerol and adonitol. Does not attack arabinose, xylose, maltose,

lactose, sucrose, salicin, mannitol, dul eitol or rhamnose.

Does not reduce trimethylamine oxide (Wood et al., Jour. Bact., 46, 1943, 106) Aerobic, facultative.

Optimum temperature 37°C. Does not grow at 45.5°C (Eijkman's reaction, Stuart et al , Jour. Bact., 46, 1943, 105). Serologically homogeneous and differ-

ent from the other species of Shigella.
Forms a potent exotovin.
Source: From widespread epidemics of

dysentery in Japan.

Habitat: A cause of dysentery in man

and monkeys.

2. Shigella ambigua (Andrewes) Wel-(Bazıllus Schmitz, Schmitz, din. Ztschr. f. Hyg., 84, 1917, 449; Bacilles ambiguus Andrewes, The Lancet, 194, 1918, 560; Bacillus dysenteriae "Schmitz", Jour. Roy. Army Med. Murray. Corps, \$1, 1918, 257; Bacterium ambiguum Levine, Abst. Bact., 4, 1920, 15; not Bacterium ambiguum Chester, Del. Col Agr. Exp. Sta. Ann. Rept., 11, 1900, 59; Eberthella ambigua Bergey et al., Manual, 1st ed., 1923, 229; Bacillus paradysenteriae X, Stutzer, Cent. f. Bakt, l Abt., Orig., 90, 1923, 12; Bacterium schmitzii Weldin and Levine, Abst Bact , 7, 1923, 13; Weldin, Ions State Gollege Jour. Sci., 1, 1927, 177; Shigella schmitzii Handuroy et al., Diet d. Bact. Path , 1937, 496 ) From Latin, uncertain.

Morphology and colony characters indistinguishable from those of Shigili dysenteriae.

Acid from glucose and rhamnose

Does not attack xylose, maltose, lactose, sucrose, dextrin, glycerol, mannitol or dulcitol.

Indole is produced.

Does not reduce trimethylamine oxide (Wood et al., Jour Bact , 46, 1943, 106).

Acrobic, facultative

Optimum temperature 37°C Does not grow at 45 5°C (Stuart et al , Jour Baet., 46, 1913, 105).

Serologically homogeneous and different from the other species of Shigella. Does not form an exotoxin

Source. Found in feecs in a dysentery epidemie in a prison in Germany.

Habitat. A cruse of human dysentery

3 Shigella gintottensis (Castellanı) Hauduroy et al. (Bacillus gintottensis Castellani, 1910; see Castellani and Chalmers, Man. Trop Med. 3rd ed. 1919, 918, Lankordes gentottensis Castellant and Chalmers, shid., 938, Castellanus gintottensis Castellani, 1930, Castellani, Jour Trop Med. and Hyg., \$6, 1933, 100; Hauduroy et al., Diet d Bact Path , 1937, 488 )

Rods. Non-motile. Gram-negative Morphology and cultural characters indistinguishable from those of Shigella dusenteriae.

Litmus milk. Acid and congulation; decolorized.

Indole not formed.

Acid, but no gas, from lactose, glucose, arabinose and galactose. No acid from sucrose, dulcitol, mannitol, maltose, dextrin, raffinose, adonitol, inulin, sorbitol, levulose, inositol, sulicin and gly cerol.

Anticenic structure not known

Source. I'rom feces in eases of dysen-

Habitat. A cause of human dysentery

4 Shigella paradysenteriae (Collins) Weldin (Bacillus dusenteriae Plexner, Phil Med Jour., 6, 1900, 414, Bacellus dysenteriae Hiss and Russell, Medical News, 82, 1903, 280; Bacillus dysenterine Strong, Jour Amer Med. Assoc, \$5, 1906, 498; Bacillus paradysenteriae Collins, Jour. Inf. Dis., 2, 1905, 620; includes weakly toxic strains of dysentery bacilli. Groups I and II, Sonne, Cent. f. Bakt., I Abt , Orig., 75, 1915, 408; Shigella flexneri Castellani and Chalmers, Man. Trop. Med., 3rd cd , 1919, 937; Shinella dysenteriae (Hiss and Russell, and Strong types) Castellani and Chalmers, ibid., 937, not Shigella paradysenteriae Castellans and Chalmers, 1bid., 937; Bacillus flexneri Levine, Jour. Inf. Dis , 27, 1920. 31; Bacterium flexneri Levine, Abst. Bact., 4, 1920, 15; Bacterium dusenteriae (Flexner type) and Bacterium paradusenterrae Holland, Jour Baet., 5, 1920, 215: Eberthella flezneri Weldin and Lavine. Abst Bact., 7, 1923, 13; Eberthella para. dusenteriae Bergey et al., Manual, 1st ed . 1923, 230; Weldin, Iona State College Jour Sci , 1, 1927, 178 ) Latinized, like dysentery.

Rods. 0 5 by 1 0 to 1.5 microns. Nonmotile. Gram-negative.

Morphologically these organisms are like Shigella dysenteriae.

Culturally these organisms differ from Shigella dysenteriae in that they forment mannitol No acid is produced from lactose, rhamnose, vylose or dulcitol.

Does not reduce trimethylamine oxide (Wood et al., Jour. Bact., 46, 1913, 106).

Does not form a potent exotoxin Aerobic, facultative

Optimum temperature 37°C Does not grow at 45 5°C (Stuart et al , Jour. Bact., 46, 1313, 103)

Antigenically the organisms of this species are not homogeneous

Boyd (Trans Roy Sic. Trop Med. and Hug., 33, 1940, 553) has shown that the manuitol-fermenting Shi jella melude many organisms previously unknown or unclassified because they did not acree with the classical types of Andre ves and Inman (Med. Res Council, Special Rept Ser. No 42, London, 1919). With there, on grounds of antigenic structure. will be included the gas forming Manchester bacillus of Downie, Wade and Young (Jour. Hyg., 33, 1933, 196) and both mannitol-fermenting and non-fermenting Newcastle bacilli (Clayton and Warren, Jour. Hyg., 28, 1929, 355 and 29, 1929, 191).

The following tables are taken from Boyd (loc. cit.).

| New Name                         | Old Name                             |  |  |
|----------------------------------|--------------------------------------|--|--|
| Bacıllus dysenteriae Flexner I   | Andrewes and<br>Isman V<br>(Flexner) |  |  |
| Bacillus dysenteriae Flexner II  | Andrewes and<br>Imman W<br>(Strong)  |  |  |
| Bacillus dysenteriae Floxner III | Andrewes and<br>Inman Z              |  |  |
| Bacıllus dysentersae Flexner IV  | Type 103                             |  |  |
| Bacillus dysenteriae Flexner V   | Type P 119                           |  |  |
| Bacillus dysenteriae Flexner VI  | 88-Newcastle-<br>Manchester<br>group |  |  |
| Bacillus dysentersae Boyd I      | Type 170                             |  |  |
| Bacillus dysenteriae Boyd II     | Type P 288                           |  |  |
| Bacillus dysenteriae Boyd III    | Type D1                              |  |  |

The six Flexner types possess a common group antigen and separate typespecific antigens The three Boyd types are distinct antigenically from each other and from the Flexner types.

Two new Flexner types (Type 953 = provisional Type VII and Type 1296/7 = provisional Type VIII) have been described by Francis (Jour Path and Baet., 58, 1946, 320) as this section goes to press. Also see Boyd (ibid., 297)

TABLE 2 -Subclassification of Bacillus dysenteriae Flexner VI (including the Newcastle bacillus)

|                                      | Lactose | Glucose | Mannitol | Dulcttol  | Sucrose | Indole |
|--------------------------------------|---------|---------|----------|-----------|---------|--------|
| Type 88 (33 per-<br>cent of strains) |         | Λ       | A        | _         |         | _      |
| Type 88 (66 per<br>cent of strains)  | -       | A       | A        | (late) A  | -       | -      |
| Manchester ba-<br>cillus             | -       | AG      | ΛG       | (late) AG |         | -      |
| Newcastle bacil-<br>lus .            | -       | AG      | -        | (late) AG |         | -      |

Source: From feces in cases of dysentery.

Habitat: A cause of dysentery in man. A cause of summer diarrhoea in children.

Note: The term Bacillus paraduses. teriae is used by Kruse (Münch, med. Wchnschr., 1917, 1309) for the Escherichia coli-like motile and gas-forming Gram-negative rods that have been found to cause dysentery-like diseases. Kruse (Deut, med, Wchnschr., 27, 1901, 338) uses the term pseudodysentery for the group that includes the Flemer. Strong, and Hiss and Russell types See Lebmann and Neumann, Bakt. Diag., 7 Aufl., 2, 1927, 456. Gardner (Med. Res. Council, System of Bacteriology, 4, 1929, 170) states that "Kruse's terms B. dysenteriae for Shiga, and Bacillus pseudodysenteriae for the Flemer. Sonne-Schmitz groups have, however, never taken root outside the Germanspeaking world".

4a. Shigella paradysenteriae (Type (Clayton and Warren, Newcastle). Jour. Hyg., 28, 1929, 355 and 29, 1929, 191; Bacillus dysenterrae Flexner VI in part, Boyd, Trans. Roy. Soc. Trop

Med. and Hyg., 33, 1940, 553.) Rods: Non-motile. Gram-negative In peptone water solution, lactose, mannitol, and sucrose not fermented

Glucose, maltose and dulcitol fermented Peculiarities of the organism are: (1) Occasionally a slight bubble of gas is produced from glucose and dulcitol, (2) when the substrate is dissolved in beef extract broth, glucose, dulcitol and maltose are always fermented to gas and

acid. Does not reduce trimethylamine oxide (Wood et al., Jour. Bact., 46, 1913, 106). Optimum temperature 37°C. Does not grow at 45.5°C (Stuart et al., Jour.

Bact., 46, 1943, 105). Acrobic, facultative.

Serologically related to the mannitolfermenting strains of Shigella paradysen terror.

Source: Isolated in 1925 from a case of diarrhoca in Newcastle-on-Tyne, England.

Habitat: A cause of human dysentery.

4b. Skigella paradysenteriae (Type Manchester). (Downie, Wade and Young, Jour. Hyg., 33, 193; Becillus dysenteriae Flexner VI in part, Boyd, Trans. Roy. Soc. Trop. Med. and Hyg., 35, 1940, 533.)

Characters as for Type Newcastle except that acid and gas are produced from mannitol. Does not produce gas from maltose.

Serologically related to the non-manutol-fermenting strains of Shigella paradusenteriae.

Source Five strains were isolated from cases of dysentery at Denton near Manchester, England. One strain came from a case of dysentery in Nigeria.

Habitat. A cause of human dysentery.

5 Shigella alkalescens (Andrewes) Weldin. (Bacillus alkalescens Andrewes, The Lancet, London, 194, 1918, 569, Bacterium alkalescens Levine, Jour. Inf. Dis., 27, 1920, 31; Eberthella alkalescens Bergey et al., Manual, 1st ed., 1922, 121; Weldin, Iowa State College Jour. Sci., 1, 1927, 179; Proshigella alkalescens Borman, Stuart and Wheeler, Jour. Bact., 48, 1914, 363) From the chemical term, alkaline.

Rods: 0 5 by 1 0 to 1.5 microns, occurring singly and in pairs. Non-motile. Grain-negative.

Gelatin stah: No liquefaction.

Agar slant. Abundant, transparent, often indescent growth.

Broth: Turbid

Litmus milk: Acid, then alkaline Potato: Moderate, grayish growth. Indole is formed

Acid but no gas from glucose, aylose, rhamnose, maltose, mannitol and dulertol Sucrose is fermented by some strains. Does not attack lactose, dextrain or salicia.

Reduces trimethylamine oxide to tri-

methylamine (Wood et al., Jour. Bact, 46, 1943, 105). In contrast to all other species of the genus, will also produce trimethylamine from choline (Wood and Keeping, Jour. Bact., 47, 1914, 309).

Aerobic, facultative.

Optimum temperature 37°C. Grows

at 45 5°C (Eijkman's reaction, Stuart et al., Jour. Bact., 46, 1943, 105).

Not pathogenie. Not agglutinated by Shiga immune serum.

Source: From feces in cases of dysenery.

Habitat: Intestinal canal.

6. Shlgella pfaffii (Hadley et al.) Welden. (Bacillus der kanarienvögelseuche, Pfaff, Cent. I Bakt., I Abt., Orig., 38, 1905, 276; Besterium pfaffi Hadley, Elkans and Caldwell, Rhode Island Agr. Exp. Sta. Bull. 174, 1918, 169; Bearllus pfaffi Hadley, Elkins and Caldwell, elbid, 201; Eberthella pfaffi Bergey et al., Manual, 1st ed., 1923, 323; Weldin, Jowa State College Jour. Sci. 1, 1927, 180). Named for Dr. Frans Pfaff of Frague who isolated this species.

Description largely from Hadley et al. (loc. cit., 180).

Rods: 0 5 by 1 0 to 2 0 microns, occurring singly. Non-motile. Gram-negative.
Gelatin colonies Small, grayish, trans-

lucent.
Gelatin stab: No linucfaction.

Agar colonies: Small, yellowish-gray, homogeneous, translucent, entire. No odor.

Agur slant: Slight, yellowish-gray, tran-lucent streak.

Broth: Turbid, with flocculent sechment (Pfaff, loc. cit., 20).

Litmus milk: Unchanged Potato: Moderate, whitish streak.

Acid but no gas from glucose, fructose, arabinose, xylose, maltose, dextrin, salicin and mannitol. Does not attack lactose, sucrose, raffinose, inulin, adoni-

tel or dulcitel Indole not formed

No lydrogen sulfide produced.

that this species should be placed in the genus Actinobacillus.

Distinctive characters: Differentiation from Shigella sonnes is made on cultural and morphological grounds and immediate fermentation of lactose.

Source: Isolated from eases of jointill in foals.

Habitat: Causes joint-ill in feals.

9. Shigella ceylonensis (Castellani) Weldin. (Bacıllus ceylonensis B, Castellani, Jour. Hyg., 7, 1907, 1; Bacillus dispar (in part) Andrewes, Lancet, 1. 1918, 500 (see Shigella madampensis and Shigella sonnei. Andrewes included in Bacillus dispar all lactose-fermenting members of the dysentery group); Lankoides ceylonensis B, Costellani and Chalmers, Man. Trop. Med. 3rd ed. 1919, 938; Eberthella dispar Bergey et al., Manual, 1st ed , 1923, 232 (see Shigella madampensis); Weldin, Iowa Sta Coll. Jour. Sci., 1, 1927, 182; Castallanus castellanıı Cerruti, Jour Trop Med. and Hyg., \$3, 1930, 207.) Latinized, pertaining to Ceylon.

Rods. Non-motile Cram-negative. Morphology and colony characters indistinguishable from those of Shigella disenteriac

Gelatin not liquefied

Litmus milk: Acid with coagulation. Indole is formed

Acid, but no gas, from lactose, glucose, fructose, sucrose, manutol, dulcitol, maltose xylose, arabinose, themnose, sorbitol, raffinose, devtrin and glycerol. Inulin, inositol, adonitol and salicin not fermented (salient differentiates Shigella ceylonensis from Bacterium coli anaerogenes Lembke, Arch. I Hyg. 28, 1895, 299)

Substances other than the monosaccharides are characteristically fermented slowly.

Reduces trimethylamine oxide to trimethylamine (Wood et al., Jour. Bact, 46, 1943, 106).

Pathogenic for guinca pigs and rabbits Scrologically the organism is stated by Castellani to be homogeneous and completely different from Shigella malampensis and Shigella sonnei. The reations to other members of the dysenten group have not been stated

Optimum temperature 37°C. Grons at 45.5°C (Stuart et al., Jour. Bact, β, 1943, 105).

Source: Isolated from the stools and intestines of persons suffering from dysentery.

Habitat: A cause of dysentery in man

10. Shigelia madampensis (Castellani) Weldin, (Bacillus madampensis Car tellani, Cent. f. Bakt., I Abt., Orig, 65, 1912, 262; Bacillus dispar (in part) An drewes, Lancet, 1, 1918, 560 (see Shigella ceulonensis and Shigella sonner), Lashordes madampensis Castellani and Chalmers, Man. Trop. Med., 3rd ed , 1919, 938; Bacterium dispar Levine, Abri Bact., 4, 1920, 15; Eberthella dispor Bergey et al., Manual, 1st ed., 1923, 232 (see Shigella ceylonensis); Welden, lows Sta. Coll. Jour. Sci , 1, 1927, ISla; Shgella dispar Bergey et al., Manual, Ind ed., 1930, 364; Proshigella dispar Borman, Stuart and Wheeler, Jour. Bact., 43,

1944, 363)
Noter (Bact. Rev., 6, 1942, 26) combines Shigella ceylonensis and S. modom pensis into a single species which has

names Shigella castellanii
Strains currently existing in vanous

jle m•

pensis (Glynn and Starkey, Jour. parts 57, 1939, 315).

Rods: Non-motile. Gram-negative.

Morphology and colony characters indistinguishable from those of Shigdla
dysenteriae.

Gelatin not liquefied. Indole is formed.

Litmus milk. Acid with cosgulation Acid, but no gas, from lactice, maltose, sucrose, arabinose, vylose, glyeria, mannitol, rhamnose, glucose, fructor, galactose and deatrin. Dulcitol, salicia, mulin, inositol and adonitol not fermented. Substances other than monosacchardes are characteristically fermented slowly.

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Reduces trimethylamine oxide to trimethylamine (Wood et al , Jour. Baet , 46, 1943, 196).

46, 1913, 106).
Serologically the organism is stated by Castellani to be homogeneous and completely different from Shegilla ceylonensis and Shigella sonner. According to Andrewes (loc. cit.), Bacillus dispers serologically distinct from Shigella alkalescens and Shigella paredysenteriae Fifteen strains (Glynn and Starkey, loc cit.) from various sources, labelled Bacillus dispar and conforming to the above description, proved to be serologically heterogeneous.

Optimum temperature 37°C. Grons at 45 5°C (Stuart et al., Jour. Bact., 46, 1943, 105).

Source Isolated from human stools

Habitat: Considered by Castellam to be a cause of collins and cystitis

11. Shigella septicaemiae (Bergey et al.) Bergey et al. (Bacillus septicaemiae anserum exsudativae Riemer, Cent f Bakt, I Abt, Orig., 37, 1994, 648, Eberthella septicaemiae Bergey et al., Manual, 2ml ed., 1925, 250, Bergey et al., Manual, 3rd ed., 1930, 338.) Latinired, of septicemia.

Small rods: 0 5 by 1 5 to 2.0 microns, occurring singly, in pairs and in threads Motile. Gram-negative.

Gelatin colonies: Small, white, circular Gelatin stab: Slight, infundibuliform liquefaction, becoming complete in sev-

eral weeks.

Agar colonies. Circular, transparent, smooth, homogeneous, entire.

Agar slant: Soft, grayish-white streak, slightly viscid, becoming transporent Does not grow on Endo agar

Broth Slight, uniform turbidity, with slight pellicle formation.

Litmus milk: Unchanged

Potato, No growth

Itlood serum Yellowish-white streek, the medium becoming brownish and slowly liquefied. Indole is formed after several days Slight acid and no gas from glucose. No acid from lactose

Hydrogen sulfide is formed.

Not pathogenie for white mice, guinea pigs, chickens or pigeons. Mildly pathogenie for ducks Aeroluc.

Optimum temperature 37°C.

Source: Isolated from blood, exudates and all of the internal organs of geese. Habitat. Cause of a fatal septicemia in young geese.

Appendix: The following species are also found in the literature. Many are incompletely described.

Bacillus coli dysentericum Cicchanoushi and Nouak (Cent. f. Bakt., I Abt., Orig., 25, 1808, 415.) From a case of disentery.

Bacillus dysenteriae Migula. (Bacillus of Japanese dysentery, Ogata, Cent. f. Bakt , 11, 1892, 261; Bacillus dysen. teriae liquefaciens Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 281; Bacterium dysenteriae liquefaciens Ches. ter, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 102; Migula, Syst. d Bakt., 2. 1900, 611, not Bacillus dysenteriae Shigh. Cent f Bakt . I Abt . 24, 1898, 817; not Bacillus dysenteriae llies ami Russell. Medical News, 82, 1903, 289; not Bacillus dysenterine Strong, Jour. Amer. Med Assoc . 35, 1906, 498; not Bacillus dusenterrae Sonne, Smith, Jour. Hyg. 25, 1921, 91) From a case of Japanese dysentery Motile Grant-positive

Bacillus dyvatericus Trevisin (Bacillus der Dysonteine, Klebs, Cent f Bakt, 2, 1837, 218, Trevisin, 1 generie le specie delle Batteriacce, 1859, 14; not Bazillus dyvateriena Ruffer and Willmore, Brit Med Jour. 2, 1993, 862.) From feces

Bacterium prindod/sentericum Kruse, (Kruse, Deutsche med Wehnsehr., 27, 1901, 370, 3%; Escherichia pseudodysenteriae Bergev et al., Manual, 1st ed., 1923, 198). From feces. Moule.

Bactersum scalefield Berger, (Jour,

Hyg., 44, 1945, 116-119.) From feces. A non-mannitol-fermenting organism of the Flexner group. Wheeler and Stuart (Jour. Baet., 51, 1946, 324) regard this as an anaerogenie paracolon.

Shigella albofaciens (Castellani) Hauduroy et al. (Bacillus albofaciens Castellani, Meetings of the Ceylon Branch of the British Medical Association. 1905; Hauduroy et al., Diet. d. Bact. Path., 1937, 482.)

Shigella arabinolarda, types A and B, Christensen and Gowen. (Jour. Bact., 47, 1914, 171-176.) From cases of dysentery in U. S. Army in Tuniaia, A lactose-negative, mannitol-negative Shigella.

Shigella bienstockti (Schroeter) Bergey et al. (Bacillus III, Bienstock, Ztschr. f. klin. Med., 8, 1884; Bacillus coprogenes parvus Flugge, Die Mikroorganismen. 2 Aufl., 1886, 269; Bacillus bienstockii Schroeter, Kryptogamen Flora von Schlesien, 3, 1, 1886, 163; Bacillus parvus Trevisan, I generi e le apecie delle Batteriacee, 1889, 15; not Bacillus parvus Neide, Cent. f. Bakt., II Abt., 12, 1904, 314; Bacierium coprogenes parvus Chester, Ann Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 85; Bacterium bienstockii Chester, Man. Determ Bact., 1901, 144; Eberthella bienstockii Bergey et al., Manual, 1st ed., 1923, 227; Bergey et al., Manual, 3rd ed , 1930, 360.) From feces,

Shigella douglasi (Castellani and Chalmers) Hauduroy et al. (Bacillus douglasi Castellanı and Chalmers, Man. Trop Med., 3rd ed., 1919, 946; Haudurey et al., Dict. d. Bact. Path., 1937, 481.)

Shigella etausae Heller and Wilson. (Jour. Path. and Bact., 58, 1946, 98.) From dysentery outbreak in an army eamp in England.

Shigella faecaloides (Castellani) Haudurov et al (Bacillus faccaloides Castellani, 1915; see Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 946; Hauduroy et al , Dict. d. Bact. Path., 1937, 488.)

Shigella giumai (Castellani) Hauduroy et al. (Bacillus giuma: Castellani, Cent. f. Bakt., I Abt., Orig., 65, 1912, 264; Wesenbergus giumai Castellani ar Chalmers, Man. Trop. Med., 3rd ed 1919, 940; Bacterium giumai Weldin an Levine, Abst. Bact., 7, 1923, 15, Sa monella giumai Bergey et al., Manua 1at ed., 1923, 220; Hauduroy et al Dict. d. Baet, Path., 1937, 483.)

Shigella lunavensis (Castellani) Hat duroy et al. (Bacillus lunavensis Cas tellani, Cent. f. Bakt., I Abt., Orig., 63 1912, 264; Bacterium lunavensis Welder and Levine, Abst. Bact., 7, 1923, 16 Hauduroy et al., Diet, d. Bact. Path 1937, 489.) From feces.

Shigella metadysenterica var. A, B, C and D (Castellani) Hauduroy et al (Bacillus metadysentericus var. A, B, C and D, Castellani, 1904; see Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 946; Dysenteroides metadysen tericus var. A, B, C, and D, Castellani and Chalmers, Ann. Inst. Past., 54, 1920, 607; Castellanus metadysentericus Castellani, 1930; Hauduroy et al., Diet. d Baet. Path., 1937, 489.) From cases of dysentery.

Shigela negombenzia (Castellani) Handuroy et al. (Bacillus negombennis Castellani, Cent. f. Bakt., I Abt., Orig. 65, 1912, 262; Hauduroy et al., Diet d. Bact. Path., 1937, 490.)

Shigella ozygenes (Ford) Bergey et al. (Bacterium oxygenes Ford, Studies from the Royal Victoria Hospital, Montreal, 1, No. 5, 1903, 47; Eberthella oxygenes Bergey et al., Manual, 1st ed., 1923, 223, Bergey et al., Manual, 3rd ed., 1930, 360.) From feces.

Shigella piscatora Bois and Roy. (Naturaliste Canadien, 71, 1945, 239) From the intestine of a codfish (Godul

callarias L.). --- (Castellani) Hau-

+ Casďι te

1912, 266; Hauduroy et al., Dict. d.

Bact. Path , 1937, 497.) From feces Shigella tarda (Castellani) Hauduroy et al. (Bacillus tardus Castellani, 1917; see Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 951; Hauduroy et al., Dict. d. Bact. Path., 1937, 497.)

#### FAMILY XI. PARVOBACTERIACEAE RAHN.\*

(Cent. f. Bakt., II Abt., 96, 1937, 281.)

Small, motile or non-motile rods Gram-negative. Some will grow on ordinary media, but the majority either require or grow better on media containing body fluids or growth-promoting substances. Some invade living tissues. Usually do not luquely gelatin. No visible gas formed in the fermention of carbohydrates. Infection in some cases may take place by penetration of organisms through mucous membranes or skin Parasitic to pathogenic on warm-blooded animals, including man.

#### Key to the tribes of family Parvobacterlaceae.

I. Usually grow on ordinary media

A. Aerobic to facultative amerobic.

1. Show bipolar staining Majority ferment carbohydrates,

Tribe I. Pasteurelleae, p. 515.

Do not show bipolar staining. None ferment carbohydrates.
 Tribe II. Brucelleas, p. 560.

B. Anacrobic

Tribe III. Bacteroideae, p 564.

 On first isolation dependent on some factor or factors contained in blood or plant tissues. Aerobic to anaerobic.
 Tribo IV. Hemophileae. p. 554.

## TRIDE I. PASTEURELLEAR CASTELLANI AND CHALMERS.

(Man. Trop. Med., 3rd ed., 1919, 913 )

Small, motile or non-motile, ellipsoidal to elongated rods showing bipolar staining.

## Key to the genera of tribe Pasteurellese.

I Milk not congulated.

A Causes hemorrhagie septicemia, pseudotuberculosis, tularemia or plaguo.

Genus I Pasteurella, p. 516.

II. Milk congulated slowly and sometimes digested.

A. Causes glanders or glanders-like infections.

Genus II. Malleomuces, p. 551.

III. Milk unchanged to slightly acid

A. Associated with actinomycous in cattle and in man.

Genus III. Actinobacillus, p. 556.

<sup>\*</sup> Revised b collaboration

Prof W. A I

Froi W. A. I. Dr. Margret Pittman, National Institute of Health, Washington, D. C.; Prof. I. F. Huddleson, Michigan State College, East Lanving, Michigan; and others, December, 1938.

## Genus I. Pasteurella Trevisan.\*

(Octopsis Trevisan, Atti della Accad. Fisio-Medico-Statistica, Milano, Scr. 4, 5, 1835, 102; Trevisan, Rendiconti Reale Instituto Lombardo di Scienze e Lettere, 1837, 91; Coccobecillus Gamaleia, Cent. f. Bakt., 4, 1889, 167; Eucystia Enderlein, Sitther. Gesell. Naturf. Freunde, Berlin, 1917, 317.) Named for Louis Pasteur, the French scientist.

Small, Gram-negative, cilipsoidal to clongated rods showing bipolar staining by special methods; aerobic, facultative; may require low oxidation-reduction potential on primary isolation; majority ferment carbohydrates hut produce only a small amount of acid; no or slight lactose fermentation; no gas production; gelatin not liquefied; milk not congulated; parasitic on man, other mammals and hirds

The type species is Pasteurella multocida (Lehmann and Neumann) Rosenbusch

and Merchant.

## Key to the species of genus Pasteurella.

I. Growth on ordinary media. Growth in milk.

- A. Non-motile and non-flagellated at 18° to 26°C. No change or slight soid in milk without coagulation.
  - Indole and H<sub>2</sub>S produced. No growth in bile. Sorbitol fermented No hemolysis on blood agar.
    - Pasteurella multocida.
    - Indole not formed. Hemolysis produced on blood agar.
       Pasteurella hemolytica.
  - 3. Neither indole nor II:S produced. Growth in bile. Sorbitol not fermented
    No homolysis.
    - 3. Pasteurella pestis.
- B. Motile and flagellated at 18° to 26°C. Milk alkaliae. Hydrogen sulfide produced. Indole not formed.
  - 4. Pasteurella pseudotuberculosis.
- No growth on plain sgar or in liquid medium without special enuchment No growth in milk
  - Pasteurella tularensis.

1. Pasteurella multocida (Lehmann and Neumann) Rosenbusch and Merhant. (Virus der Wildseuche, Hueppe, Berlin kln. Wochnschr., 23, 1836, 797; Bactérie ovoide, Lignières, Reeuenl de Méd. Vétér, 75, 1898, 836 (Bull. Soc. Centr Méd. Vétér., N. S. 69, 1898, 836); Bacillus septicaemiae haemorrhagicae Sternberg, Man. of Bact., 1893, 408; Bacterium septicaemiae hemorrhagicae Lehmann and Neumann, Bakt. Diag, 2 Aufl., £, 1899, 194; Bacterium nultoci-

dum Lehmann and Neumann, ibid., 195; Bazillus plurisepticus and Bacterum acticidum Kitt, in Kolle and Wasserman, Handb. d. path. Mikroorg., 1 Auf., 2, 1903, 562; Bazillus pleurisepticus Jodna, General Bact., 1st ed., 1908, 293; Bazillus bipolaris septicus Hutyra, in Kolle sad Wassermann, Handb. d. path Mikroorg. 2 Aufl., 6, 1913, 67; Bazillus bipolars plurisepticus Hutyra, ibid.; Pasteurella septicus Topley and Wilson, Princip Bact. and Immun., 1st ed., 1, 1931, 485;

Rearranged by Mrs. Eleanore Heist Clise, New York State Experiment Stateon, Geneva, New York, in accordance with the suggestions of Mr Philip C. Harvey and Dr. Mark Welsh, Pearl River, New York, November, 1945.

Pasteurella pluriseptica Gay et al., Agents of Disease and Hast Besistance, 1933, 730; Rosenbusch and Merchant, Jour Bact., 57, 1939, 85.) From Latin, killing many.

The following are regarded as identical rith the above but are arranged here according to source

Pasteurella bollingeri Trevisan. (Mieroparasiten ber eine neue Wild- und Rinderseuche, Bollinger, Über eine neue Wild- und Rinderscuche unsw., Munchen, 1878; Bacterium bipalare multocidum Kitt, Sitz. Gesell, Morphol. u. Physiol., München, 1, 1885, 24; Trevisan, I generl e le specie delle Batteriacee, 1889, 21; Bacillus botiscpticus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl , 2, 1896, 421; Bacterium borisepticus Chester, Ann. Rept, Del. Coi. Agr. Exp. Sta , 9, 1897, 81; Bactersum inultocidum Lehmann and Neumann, Bakt Dieg., 2 Aufl., 2, 1899, 196; La Pasteurella bovine, Lignières, Recueil de Méd. Vétér, 77, 1000, 537; Bacillus birolaris borisepticus Hutvra, In Kolle and Wassermann, Handb d path, Mikroorg, 2 Aufl, 6, 1613, 67 , Pasteurella bairseptica Holland, Jour Bact., 5, 1920, 221; Pasteurella barrum Hutyra, in Kalle, Kraus und Uhlenhuth, Handb. d. path Mikroorg., 3 Aufl , 0, 1927-1929, 487; Pasteurella ferarum Hauduroy et al , Dict. d Bact. l'ath , 1937, 316.) From domestic cattle and deer.

Pasteurella asseida (Gamalela) Trevisan. (Microbe du cholera des poules, Pasteur, Compt. rend Acad Scs., Paris, 90, 1880, 239, 952 and 1030; Granules of fowl cholers, Salmon and Th Smith, U. S. Dept. Agr. Ann. Rept., 1880, 439; Mierococcus cholerae gallinarum Zopf, Die Spaltpilze, 3 Aufl , 1885, 57 : Octopsis cholerae gallinarum Trevien, Atti della Accad Pisio Medico Statistica, Milano, Ser 4, 3, 1885, 102; Hacillus chelerae oallinarum l'Ingge, Die Miknorganismen, 2 Aufl , 1586, 253, Bacterium cholerae gallinarum Schroeter, Kryptogumen Flora von Schlesien, 3, 1, 1886, 155; Hühnerebolerabseterien, Kitt, Cent. f.

Bakt., 1, 1887, 305; Pastcurella cholerae gallmarum Trevisan, Rendiconti Reale Instituta Lombardo di Scienze e Lettere, 1887. 91: Coccobacillus avicidus Gamaleia, Cent. f. Bakt., 4, 1888, 167; Trevisan, I generi e le specie delle Batteriacec, 1889, 21; Bacterium avicidum Kitt, according to Chester, Man Determ. Bact . 1901, 135; Bacterium cholerae Chester. idem; Bacillus arisepticus and Bacterium atisepticum Kitt, in Kolle and Wassermann, Handb, d. path Mikroorg., 1 Aufl., 2, 1903, 544; not Bacellus arisepticus Chester, loc. cit., 220, Pasteurella arium Kitt, loc. cit., 502; Pasteurella gallinae Besson, Practical Bactenalogy, London and New York, 1913, 417; Pasteurella cholerac-gallinarum Winslaw et al., Jaur. Bact., 2, 1917, 561; Bacillus cholerae gallinarum Holland. Jaur. Bact., 5, 1920, 217; Pasteurella auseptica Holland, ibid., 221.) From fan Is.

Pasteurella. cuniculicida (Tlugge) Trevisan. (Septicămiebacterien, Gaffky. Mrt kniserl Gesundheitsamte, I. 1881, 98; Bacillus cuniculicida Flügge, Die Mikroorganismen, 2 Aufl., 1886, 251; Trevisan, I generi e le specie delle Batteriscee, 1889, 21; Bacterium septichaemiae Schroeter, Kryptogamen I lora von Schlesjen, 3, 1, 1889, 155; Bacterium euniculicida Chester, Ann Rept. Del. Col. Agr. Exp. Sta , 9, 1897, 80; not Bacterium cuniculicida Chester, Man, Determ Bact , 1901, 140; Bacillus euniculisepticus Kitt, in Kolle and Wassermann, Handle. d. path. Mikroorg , I Aufl., 2, 1903, 562; Bacterium lepisepticum Ferry and Hoskins, Jour. Jab and Clin. Med., 5, 1930. 311; Bacillus bipolaris septicus and Bacillus lepiscoticus Ford, Texth. of Bact , 1927, 591; Pasteurella lepiseptica Holland, Jour. Pact , 5, 1900, 221; Parteurella euniculi Schatze, Med. Hen Council, Syst. of Bart , London, 4, 192), 469; Boeterium leportsepticum Handuroy et al , Diet. d. Bact. Path , 1937,

Pasteurella suella Trevienn. (Hothlaufstabelien, Leeffer, Arb. kaiserl. Ge-

314.) From rabbite.

sundheitsamte, 1, 1886, 51; Rothlaufbacillen, Schutz, ibid., 74; Bacillus of swine plague, Salmon, Rept. U. S. Dept. Agr., Bur. An. Ind., 1886, 87; Bacillus parvus ovatus Flügge, Die Mikroorganismen, 2 Aufl., 1886, 273; Trevisan, Reale Instituto Lombardo d. Sci. e Let. Rend., Ser. 2, 20, 1887, 94; Bacterium suicida Migula, in Engler and Prantl, Naturl. Pflanzenfam., 1, Ia, 1895, 27; Bacillus suisepticus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 419; Bacterium suisepticus Chester, Ann. Rept. Del, Col. Agr. Exp. Sta., 9, 1897, 80; La Pasteurella porcine, Lignières, Recueil de Méd. Vétér., 77, 1900, 391; Pasteurella suiseptica Holland, Jour. Bact., 5, 1920, 220; Pasteurella suum Hutyra, in Kolle, Kraus and Uhlenhuth, Handb. d. path. Mikroorg., 3 Aufl., 6, 1927-1929, 487.) From swine.

Bacterium boricida Migula. (Microbo del barbone dei bufafi, Oreste Armanni, Atti, d. R. Istit. d'incornge, alle sciente natur. ecenom. e technol., 1857; Letta nella tornata Accad, Sept. 16, 1886; Cent. f. Bakt., 2, 1857, 60; Atti della Commissione per le malattie degli animalı, 121, 1857; Migula, Syst. d. Bakt., 2, 1000, 366; Pasteurella bubalseptica Kelser, Man. Vet. Bact., 1st ed., 1927, 195; Bacillus bubalsepticus Kelser, ibid.; Bacillus bupalarşı bubalisepticus Hauduroy etal., Dret. d. Bact. Path., 1937, 312.)

From buffalces

Pasteurella vituliseptica (Kitt) Ford.

(Bacillus vitulisepticus Kitt, in Kolle
and Wassermann, Handb. d. path, Mikroors., 1 Aufl. g., 1903, 562; Bacterium
vitulisepticum Lehmann and Neumann,
Bakt. Diag, 5 Aufl., g., 1912, 282; Ford,
Textb. of Bact., 1927, 597.) From
calves.

Pasteurella muricida Meyer and Batchleir. (Meyer and Batchelder, Jour. Inf. Dis., 59, 1926, 586; Pasteurella muriseptica Topley and Wilson, Princip. Bact. and Immun., 1st cd., 1, 1931, 482; not Pasteurella muriseptica Bergey et al., 1st cd., 1923, 265 (Bacillus murisepticus Flügge, Die Mikroorganismen, 2 Aufl., 1886, '250; Erysipelothrix muriseptica Bergey et al., Manual, 2nd ed., 1925, 380).) From pild rats.

Bacillus bipolaris der malignen Meerschweinehen-Phlegmasie of Heymans ad Kyrinsides, Ztschr. f. Hyg., 114, 1932, 119 (Klebsiella cariae Hauduroy et al., Dict. d. Bact. Path., 1937, 201) is stated by the original authors to be closely related to this ornamism.

Plasaj and Pribram (Cent. f. Bakt., I Abt., Orig., 87, 1921, 1) also present a classification of the hemorrhagic septi-

cemia bacteria.

Description from Schutze (Med. Res.
Council, Syst. of Bact., London, 4, 1929,
451) who prepared it from studies of 230
strains described by 17 authors during

the years 1903-1926.

Short ellipsoidal rods: 0 3 to 1.25
microns in length, occurring singly, in
pairs, rarely in chains. Show bipolar
staining. Non-motile. Gramnegative.

Gelatin: No liquefaction.

Agar: Fine translucent growth. Char-

acteristic odor. Broth: Uniform turbidity. Charac-

teristic odor.

Milk: No change in reaction. No congulation.

Potato: No visible growth.
Indole is formed.

Nitrites are produced from nitrates.

Hydrogen sulfide is produced.

No bemolysis on blood agar.

Acid but no gas from glucose, mannit

Acid but no gas from glucose, mannitol (usually), success, fructose, sorbitol, m lacanus.

dalin, maltose (usually), isfinose, rhamnose, adonitol, destrin, inulin, glycerol, salicin (usually) or erythritol.

Optimum temperature 37°C. Killed

at temperatures above 45°C

Acrobe to facultative anaerobe.

Three scrological types have been found on the basis of agglutination tests
(Little and Lyon, Amer. Jour. Vet. Res., 1913, 110).

Virulent for laboratory snimals, especially mice and rabbits.

Distinctive characters: Grows on nrdinary media. Bile salts inhibit growth. Source: From numerous domestic animals and fowls, including cat, dog, cattle, horse, goat, sheep, pig, rabbit, chicken.

and from reindeer, buffalo, rat, etc.

Habitat: The cause of hemorrhagic septicemia in birds and mammala.

 Pasteurells hemolytics Newsomand Cross. (Jour, Amer, Vet. Med Assoc., 89 (N.S. 35), 1932, 715.) From M. L., hemolytic.

Bipolar staining.

Blood agar: Hemolysis, Indole not formed,

Acid from devtrin, fructore, galactose, glucose, glucose, glucose, glucose, glucose, mannatol, nafinose, corbitol, sucrose and xylose No acid from arabinose, dulettol, inulin, mannose, rhampose or salicin.

No cross-agglutination between Pas-

Avirulent for rabbits.

Source. Twenty strains isolated from pneumonia in sheep and cattle.

Habitat: Occurs in pneumonia of sheep

3 Pasteurella pestis (Lehmann and Neumann) Holland. (Bacille de la peste. Yersin, Ann. Inst. Past., S, 1991, 666; Pest Bacillus, Aoyama, Ztschr. f. Hyg., 91, 1895, 165; Bacterium pestis Lehmann and Neumann, Bakt. Disg , I Aufl., 2, 1896, 191; Bacillus pestis bubonicae Kruse, in Flagge, Die Mikroorganismen. 3 Aufl , 2, 1896, 429; Bacterium pestis bubonicae Chester, Ann Rept. Del. Col Agr Exp. Stn., 9, 1897, 81; Bacellus pestra Migula, Syst. d. Bakt., 2, 1900, 749, Eucystia pestis Enderlein, Sitzber. Gesell Naturf, Freunde, Berlin, 1917. 317, Holland, Jour. Bact., 5, 1920, 219, Coccobacillus persini Neveu-Lemsire, Prices Parasitol, Hum. 5th ed., 1921. 20 ) from Latin pestus, plague.

Rods: 10 by 20 micross, occurring

singly. Non-motile. Polar staining. Characteristic bladder, safety-pin and ring involution forms. Gram-negative. Gelatin colonies: Flat. grav. with

granular margin.

Gelatin atsb: Flat surface growth.

Arborescent growth in stab. No lique-

Agar colonies: Grayish-white, translucent, irridescent, undulate.

Agar slant: Growth grayish, viscid, thin, moist, translucent. Growth slow, favored by the addition of blood or sodium sulfite.

Broth: Turbid or clear with flocculi in the fluid. Old cultures show a pellucle with streamers into the fluid (stalactites). Becomes alkaline more slouly than Pasteurella pseudotuberculosis. See Bessonoma and Lenskaja, Cent. f. Bakt, I Abt., Orie. 119, 1930, 430.

Litmus milk: Slightly acid or unchanged. No congulation.

Potato. Scanty, grayish growth.

I otato. Scanty, grayish growth

Lactose and rhamnose not attacked. Variable action on glycerol.

Nitrites are produced from nitrates, Temperature relations: Optimum 25° to 30°C, Minimum 0°C. Maximum 43° to 45°C.

Aembie, lacultative.

Source Buboes, blood, pleural effusion, spleen and liver of infected rodents and man. Sputum in pneumonic plague. Infected fleas.

Habitat: The causative organism of plague in man, rats, ground squirrels and other rodents. Infectious for mace, guinea pigs and rabbits. Transmitted from rat to rat and from rat to man by the infected rat fee.

Norn: Pasteurella pestis and Pasteurella presidotherceloria are not definitely distinguishable by semberical methods (Schötze, Med Res. Council, Syst. of Ract., London, 4, 1929, 478, and Wu Lieu-teh, in Clun, Ibiliter and Wu, "Tigue," National Quarantire Service, Sharghai, 1639). Maiseldre green broth slowly decolorized by Pasteurella pestis slowly decolorized by Pasteurella pestis and Chalmers (Man. Trop. Med., 3rd ed., 1919, 941). The organism described by Tretrop clearly was not the same as that in the culture sent by Binot of the Pasteur Institute to MacConkey and described by him (loc. cit.) as a member of the coliform group. Because of Mac-Conkey's studies, the Binot culture has been accepted as determining the nature of Bacillus coscoroba in many subsequent studies of the coliform group, e.g., Bergey and Deehan, Jour. Med. Res., 19, 1908, 182; Levine, Amer. Jour. Pub. Health, 7, 1917, 785; Winslow, Kligler and Rothberg, Jour. Bact., 4, 1919, 485; Bergey et al., Manual, 1st ed., 1923, 204; etc.

Bacillus cunteulicida Migula. (Bacillus der Kaninchenseptikämie, Eberth
and Mandry, Arch. f. path Anat., 121,
1890; Bacillus cunteulicida mobilis Kruse,
in Flugge, Die Mikroorganismen, 3
Anfl., 2, 1890, 406, Bacterium cunteulicida
mobilis Chester, Ann. Rept Del. Col.
Agr. Exp. Sta., 9, 1897, 132; Migula,
Syst. d. Bakt., 2, 1900, 757, not Bacillus
cunteulicida Flugge, Die Mikroorganismen, 2 Aufl., 1880, 251.) From peritoneal exudate of a rabbit.

Bacillus mustelaccida Trevisan. (Bacillus der Frettchenseuche, Eberth and Schimmelbusch, Fortschr d Med, 6, 1889, 295; also see Arch. f path. Anat., 115, 1889, 282; Trevisan, I generi e le specio delle Batteriarce, 1889, 13; Pasteurella mustelaccida DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1880, 996; Bacellus mustelac septicus Krusc, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 405, Bacterium mustelac septicus Chester, Ann Rept. Del Col Agr. Exp. Sta. 9, 1897, 138; Bacillus mustelac Migula, Syst de Bakt. 2, 1990, v and 756.) From a disease of ferrets

Bacterium anatis Migula (Bactéries du choléra des canards, Cornil and Toupet, Compt. rend Acad. Sci. Paris, 106, 1888, 1747; Bacillus cholerae anatum Kruse, in Flugge, Die Mikroorganismen, 3 Aufl. 2, 1896, 417; Migula, Syst. d. Bakt., 2, 1900, 364.) Regurded as the cause of duck cholera and very similar to, if not identical with, Pasteurella asicida. See Rettger and Scoville, Jour. Inf. Dis., 20, 1920, 220. From the blood and other organs of infected ducks.

Bacterium cuniculi Migula. (Bacillus der Brustseuche des Kaninchens, Beck, Ztschr. f. Hyg., 15, 1893, 363; Bacillus cuniculi pneumonicus Kruse, in Flügge, Die Miknoorganismen, 3 Aufl., 2, 1896, 418; Bacterium cuniculi pneumonicus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 84; Migula, Syst. d. Bakt., 2, 1900, 370; Bacterium becki' Chester, Man. Determ. Bact., 1901, 142) Associated with a lung plague of rabbits.

Bacterium haemorrhagicum (Kruse) Lehmann and Neumann. (Kolb, Art. Kaiseri. Gesundheitsamte, 7, 1892, 60; Bacillus haemorrhagicus Kruse, in Flügge, Die Mikroorganismen, 3 Aufi., 2, 1896, 421; Lehmann and Neumann, Dakt. Diag., 1 Aufi., 2, 1896, 194.) From the mucous membranes of fever patients.

Bacterium palumbarium Migula. (La bactério de la maladie des palombes, Leclainche, Ann. Inst. Past., 8, 1894, 493; Bacillus cholerae columbarum Kruse, in Fitege, Die Mikroorganismen, 3 Auf. 2, 1896, 417; Bacterium cholerae columbarum Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 81; Migula, Syst. d. Bakt., 2, 1900, 368; Bacterium columbarum Chester, Man. Determ. Bact., 1901, 141.) Associated with an epidemic

in wild pigeons.

Bacterium phasianitida Klein.
(Klein, Ceut. f. Bakt., I Abt., Orig., 31, 1902, 76; Bacterium phasianidarum mbele Enders, Berl. tierartil. Wchaschr., No. 23, 1902; abst. in Cent. f. Bakt., I Abt., Ref., 34, 1904, 381) From epidemic in pheasants (England). Hadley, Elkina and Caldwell (Klade Island Agr. Exp. Str., Bull. 174, 1918, 29) state that this species (which they call B. phasianicada) belongs in the group of paratypholis (Salmonello).

Bacterium purpurum Chester. (Bacillus of purpura-haemorrhagica, Babes, Septiche Proz Kindesalters, Leipzig. 1859; Bacillus haemorrhagicus cepticus Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 421; Bocterium haemorhagieus septicus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 85; Chester, Man. Determ. Bact., 1901, 143.) From a case of septicemia in man

Bacterium titzonii Nigula. (Bacillus der haemorrhagischen Infektion, Titzoni and Giovannim, in Zeigler, Beiträge, 7, 1889, 300; Bacillus haemorrhagieus telenosus Kruese, in Flügge, Die Mikroorginismen, 3 Aufl., 2, 1896, 425, Bacterium haemorrhagieus velenosus Chester, Ann Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 85; Migula, Syst. d. Bakt., 2, 1900, 359; Bacterium velenosum Chester, Man. Determ. Bact., 1901, 144.) From the blood of a child having a hemorrhagie infection.

Bacterium ressalei Migula (Tirzon and Giovannin; In Zeigler, Benträge, 7, 1889; Bacillus haemorrhagueus nephriudis Kruse, In Tidgge, Die Mikroorganismen, 3 Aufl 2, 1890, 421; Bacterum haemorrhagieus nephriudis Chester, Ann Rept Del. Col. Agr. Exp. Sta., 9, 1897, 85, Migula, Syst. d. Bakt, 2, 1900, 357, Bacterium nephriidis Chester, Man Determ. Bact., 1901, 115 J. Solated by Vassalo from a case of hemorrhagie nephrius

Pasteurella bouffards Commes (Commes, 1919; quoted from Nevou-Lemaire, Précis de Parisitol. Hum, 5th ed, 1921, 21.) The cause of a human pusteurellous observed by Bouffard at Bannako in 1909.

Pasteurila caniseptica Hauduroy et al (Pasteurila du chen, Lignières, Recueil de Méd. Vét., 77, 1900, 409, Bacteriuri conicida Lelimann and Neumann, Bakt Drig, 4 Auf. 2, 1907, 277, Hauduroy et al, Diet. d. Bact. Path., 1937, 312.) From dogs.

Posteurella capraspitea (Lanfranchi and Pacchoni) Hauduny et al (Bacillus preumonine caprae Nicolle and Refallley, Ann. Inst. Past., 10, 1806, 221, Pasteurella du chevre, Lignières, Recueil de Méd. Vétér, 77, 1909, 536, Bacillus capraspiteus Lanfranchi and Pacchoni, 1926; Bacillus bipolaris caprisepticus Chefik Kohayi and Rali, 1935, Hauduroy et al., Duct. d. Bact. Path. 1937, 313.) From hemershague septicemma in goats. Pasteurella carine Hauduroy et al. (Catéand Billa, Compt. rend. Soc. Bol., Paris, 99, 1928, 814; Hauduroy et al., Duct. d. Bact. Path., 1937, 313) From a guinea pig with a tuberculosis-like disease.

Pasteurella cariseptea (Schwer) Haudeurella option et al (Pasteurella du cobaye, Phusalix, Compt. rend. Soc. Biol., Paris, I. 1893, 761, Bacterium corresponding Schwer, Cent. f. Bakt., I Abt., Orig., 33, 1902, 47; Hauduroy et al., Diet. d. Bact. Path., 1937, 314.) From hemorrhagie septuerma in guines pigs.

Pasteurella desmodills Piris (Pub So African Inst. Med Res., 4, 1929, 191)

Pasturella equiseptica Kelser. (Bacille de la septicémie lémorragique du cheval, Lignuères, Bull. Soc Centr. d Méd. Vét., 15, 1897, 437 and 19, 1898, 819; La Pasteurella equine, Lignuères, Recueil de Méd. Vét., 77, 1800, 521; Kelser, Man. Vet. Bact., 1st. ed., 1937, 191; Bacillus equisepticus Kelser, ibid., Bacillus pneumoniae equi Poles.) Trom borses.

Pasteurella Jelis (Migula) Hauduny et al (Bacillus solirorus espicus filis Florca, Ann d Instit. d'Igene di Univ. di Roma, 2, 1822 and Cent. 1 Bakh., 11, 1892, 406, Boeillus Jelis septieus Niture, in Flogge, Die Mikroorganismen, 3 Aufl. 2, 1806, 423; Bacterum felis septieur Universitätis of the State of Bakt., 2, 1897, 81, Pasteurilla du chat, Lignières, Recueil de Mid. Vici., 77, 1900, 493, Bacterum Jelis Migula, Syst. de Bakt. 2, 1909, 375, Haudury et al., Diet de Bact. Path., 1937, 316) From the smutum of a cat.

Patteurilla matthis (Miesener, and Schoop) Hauduroy et al. IStabelientalterium, Dammann and Freese, Deut. terderill Welmschr. 13, 1907, 165, Bupolar organism of the Patteurilla group, Leysbon, Vet Jour., 83, 1929, 299, Batterium mathildis Miesener and Schoop, Deut. tierfirstl. Welmschr., 40, 1932, 69; Pasteurella, Marsh, Jour. Amer. Vet. Med. Assoc., 81 (N.S. 34), 1932, 376; Bacterium ovinum Haupt, Cent. I. Bakt., I Abt., Orig., 128, 1932, 365; Hauduroy et al., Dict. d. Bact. Path., 1937, 316.) The cause of infectious mastitis of ewes.

Pasteurella necrophora Hauduroy et al. (Bacille de la nécrose infectieuse des Canaris, Cornell, The Vet. Record, 84, 1928, 350; Hauduroy et al., Diet. d. Bact. Path., 1937, 318.) From domestic canaries.

Pasteurella oviseptica Hauduroy et al (Galtier, Jour. d. méd. vét. et d. 200t., 1839-1890, 58, 113 and 481; La Pasteurella ovine, Lignières, Recueil de Méd. Vétér., 77, 1900, 522; Bacillus bipolaris ovisepticus Hutyra, in Kolle and Wassermann, Hand. d. path. Mikroand Wassermann, Hand. d. path. Mikro-

org., 2 Aufl., 6, 1913, 67; Hauduroy et al., Dict. d. Bact. Path., 1937, 319.) From sheen.

Pasteurella pericardits Hauduroy et al. (Bacterium cavarum pericardits Iloth, Acts Pathol. et Microb. Scand, 11, 1934, 335; Hauduroy et al., Dict. d. Bact. Path., 1937, 319.) From guinea pirs.

Pasteurella strasburgensis Hauduroy et al. (Coccobacille de Strasburg, Debre, Compt. rend, Soc. Biol., Pais, 82, 1919, 224; Hauduroy et al., Diet. d. Bact. Path., 1937, 323.) From a case of purulent pileurisy.

Pfeiferella analipestifer Hendrickson and Hilbert. (Inchrickson and Hilbert, The Cornell Veterinarian, 22, 1932, 239; Hemophilus analipestifer Hauduroy et al., Diet. d. Bact. Path., 1937, 247. From a septicemic disease of ducks.)

## Genus II. Malleomyces Pribram.\*

(Cladascus Enderlein (in part), Sitzber. Gesell. Naturi. Freunde, Berlin, 1917, 316, Pfeifferella Buchanan, Jour. Bact., 3, 1918, 54; Pribram, Klassification dar Schizomyceten, Leipzig, 1933, 11 and 93; Loefferella Gay et al., Agents of Discase and Host Resistance, Indianapolis, 1935, 782.) From Latin malleus, glanders and succes, fungus.

Because Pfeifferella was proposed inadvertently (Buchanan, Gen. Syst. Bact., 1925, 420) and because of a general feeling that it is inappropriate, Malleomyces Pribram is used as the aerliest suitable name for this genus. The indefinite description of a organism (Malleomyces equestris) by Hallier (Ztschr. f. Parasitenkunde, 1870, 119) as the cause of glanders has not previously caused confusion and need not do so in the future.

Short rods, with rounded ends, sometimes forming threads and showing a tendency toward branching. Motile or non-motile. Gran-negative. Tendency to bipolar staining. Milk slowly cosgulated. Gelstin may be liquefied. Specialized for parasitic life. Grow well on blood serum and other body fluid media.

The type species is Malleomyces mallei (Flugge) Pribram.

# Key to the species of genus Malleomyces.

- Carbohydrates not fermented. Honey-like colonies on potato. Glycerol agar colonies slimy or tenacious, translucent. Non-motile.
  - 1. Malleomyces mallei.
- II. Carbohydrates fermented. Profuse, creamy growth on potato. Glycerol agar colonies indescent, becoming corrugated Motile.
  2. Malleomyces pseudomallei.

Revised by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, December, 1938; further revision, December, 1945.

Malleomyces mallel (Zopf) Pri-(Rotzpilz, Löffler and Schütz, Deutsche med. Wchnsehr., No. 52, 1882; Bacillus maller Zopi, Die Spaltpilze, 3 Aufl , 1885, 89; Rotzbacillus, Loffler. Arb. kaiserl. Gesundheitsamte, 1, 1886. 222: Bacterium malles Migula, in Engler and Prantl. Die natur! Pflanzenfam . 1. 1a. 1895. 21; Corynebacterium maller Lehmann and Neumann, Bakt Diag, 2 Aufl., 2, 1899, 366; Mycobacterium mallei Chester, Man. Determ Bact , 1901, 353; Cladascus mallei Enderlein, Sitzber Gesell. Naturf. Freunde Berlin, 1917, 395. Pfeifferella mallei Buchanan, Jour Bact., 3, 1918, 54; Sclerothrex maller Vuillemin, Encyclopedie Mycolog , Paris, 2. Champignons Parasites, 1931, 135, Brucella mallei Pacheco, Revista da Sociedado paulista de Medicina veterinaria, 3, 1933, 1; Actinobacillus mallei Thompson, Jour. Bact , 26, 1933, 226, also Jour. Bact., 25, 1933, 41, Pribram, Klassification der Schuzomyceten Leipzig and Vienna, 1933, 93; Loefflerella maller Gay et al., Agents of Disease and Host Resistance, Indianapolis, 1935, 782.) From Latin malleus, glanders, a theeaso of horses.

Bacillus ozende Trevisan (Corr Ser, 1881, n. 222) is identical with this species according to Trevisan (I generic le specie delle Batterlacce, 1889, 13)

Description largely from Kelser, Man Vet. Bact., 2nd ed., 1933, 325

Slender rods: 0.5 to 10 by 20 to 50 microns, with rounded ends, usually occurring singly, in pairs and in groups, but may grow into filaments. Branching robustion forms on glycerol sgut Show arregular staming [Bipolar staming common, Non-motile] Gram negative.

Gelatin: Poor growth. Usually no liquefaction. May be slowly liquefied (Jordan, General Bact, 11th ed., 1935, 491).

Agar colonies. Moist, grayish white layer, translucent, ropy, with regular torders. Later become jellowish or yellowish-brown.

Agar slants: Glistening, moist, ropy, grayish-white growth.

Löffler's serum: Good growth. Moist, viscid, yellowish colonies develop after 36 to 48 hours.

Broth. Turbid, sometimes with thin pellicle. Slimy or ropy sediment.

Latmus milk: Coagulation usually occurs after a week with some acid production. Litmus may or may not be reduced.

Potato. After 36 to 48 hours, pale yellow, hency-drop-like colonies. Later becoming darker, reddish-yellow or chocolate color. The medium sometimes has a faint greenish tingo around the growth. Indole not formed.

Nitrites not produced from nitrotes Carbohydrates usually not fermented Some strains produce small amounts of acid from glucose.

Optimum temperature 37°C No grantii belon 20°C or above 44°C. terobic, facultative anaerobic.

Common name Glanders bacillus.
Distinctive characters Culture media
of sightly neid reaction best suited for
growth, addition of glycerol favors
growth, honcy-like growth on potato.

Source Isolated by Löffler and Schütz from the liver and spleen of a horse. Lexions in snimals and man.

Halatst The cause of glanders, affecting horses, man, sheep and goats. Transmissible to dogs, cats, rabbits and guines pigs

2 Malleomyces pseudomallel (Whitmore) Breed. (Bacillas preudomaltei Whitmore, Jour 11)g, 13, 1913, 1, Bacillas whitmore Stanton and Fletcher, Trans 1th Cong Far Last Arsn. Trop. Med. 2, 1921, 196, also Jour. 11yg, 23, 1923, 317, Pfeifferella pseudomallel Ford,

Vullemin, Encyclopédie Mycolog., £, Chempignons Parasites, 1931, 136; Actinobacillus preudoriallei Thompson, Jour. Bact., £6, 1933, 220; also Jour. Bact., Aerobic, facultative.

Distinctive character: Manner of growth in liquid gelatin.

Source: Found in lesions of actinomycosis.

Habitat . Presumably in actinomycotic lesions

3. Actinobacillus actinoides (Smith) Topley and Wilson. (Bacillus actinoides Th. Smith, Jour. Exp. Med., 28, 1988, 333; Actinomyces octinoides Bergey et al., Manual, 1st ed., 1923, 346; Topley and Wilson, Princip. of Bact. and Immun., 1st ed., I, 1931, 256.) From Greek, ray-like.

Slender rods in tissues. In cultures may be bacillary or coccoid in form, Grows only under increased CO, teosion (so-called microacrophille). Does not grow on ordinary agar or both, except occasionally when transferred from more favorable media. Most characteristic growth on coagulated blood serum.

Gelatin: No growth.

Agar colonies · Very minute, pale, straw

color.

Agar slant: Best growth seen in water of condensation. Serial transfers on this medium generally fail.

Broth: No growth.

Litmus milk: No growth.

Potato: No growth.

Coagulated blood serum (cow): Growth appears first in the condensation water. Appear as granules, consisting of capsular material in which bacillary forms are embedded. Surface mulberry-like because of club-like extensions of capsular material. In stained preparations, the capsular material appears amorphous

Optimum temperature 37°C,

Microaerophilic.

Not pathogenic for laboratory animals, except possibly the white rat in which a spontaneous chronic pneumonus occus caused by an organism indistinguishable from this one. Experiments with rats by artificial inoculation have not been reported.

Source: From lungs of calves suffering

from chronic pneumonia.

Habitat: Has not been recognized in nature except in pathological processes

#### \* APPENDIX TO TRIBE PASTEURELLEAE.

While the authors who describe the following new genus with its single species do not indicate its general relationships, it would appear to be as closely related to the species placed in Partobacteriaceae as to those in any other family. It is therefore placed in this appendix pending a clarification of the situation.

Genus A. Donovania Anderson, De Monbreun and Goodpasture.

(Jour. Exp. Med., 81, 1945, 25.) Named for C. Donovan who first described the type species.

Pleomorphic non-mottle rods, edubiting single or bipolar condensations of chromatin. Occur singly and in clusters May be capsulated or non-capsulated. Gram-negative. Growth outside luman body occurs only in the yolk, yolk sac or anniotic fluid of developing chick embryo or in a medium containing embryonic yolk, Pathocenic for man causing eranulomatous lesions, rarticularly in the inquisal recion.

The type species is Donorania granulomatia Anderson, De Monbreun and Good-nasture.

I Donovania granulomatis Anderson et al. (Epithelial cell parasites, Donovan, Indian Med. Gaz., 49, 1903, 414; Donovan bodies, Dienst, Greenblatt and Sanderson, Jour. Inf. Dis., 62, 1935, 112. Donovan organism, Anderson, Science, 97, 1913, 500; Anderson, De Monbreun and Goodpasture, Jour. Exp. Med., 81, 1915, 23.) From M. L. granuloma, of granuloma, of granuloma.

Pleomorphic rolls 1 to 2 inicrons in length, with rounded ends, occurring singly and in clusters. Intracellular forms usually capsulated. Non-motile Gmu-negative.

No growth on ordinary culture media. Cluck embryo, Grows readily in yolk, yolk sac and feebly in amniotic fluid of developing chick embryo

Embryonic yolk medium Grawth occurs

Distinctive characters: Capsulated forms readily demonstrated by means of Wright's stain as blue bacillary bodies surrounded by well-defined dense pinkshe capsules Non-capsulated forms variable in norphology. Characteristic

safety-pin forms may be demonstrated.

Not pathegenic for the common experimental animals.

Source Granulomatous lesions of man, Habitat: Human lesions. The cause of granuloma inguinale.

<sup>\*</sup> Prepared by Dr. Orren D. Chapman, Syracuse Medical College, Syracuse, New York, March, 1946

# TRIBE II. BRUCELLEAR BERGET, BREED AND MURRAY.

(Preprint, Manual, 5th ed., October, 1938, vi.)

Small, motile or non-motile rods or coccoids which grow on special media. There is a single genus Brucella.

#### Genus I. Brucella Meyer and Shaw,\*

(Jour. Inf. Dis., 27, 1920, 173.) Named for Sir David Bruce, who first recognised the organism causing undulant lever.

Short rods with many coccoid cells, 0.5 by 0.5 to 2.0 microns; non-motile; capsulated; Gram-negative; gelatin not liquefied; neither acid nor gas from carbohydrates; urea utilized; parasitic, invading all animal tissues, producing infection of the genital organs, the mammary gland, the respiratory and intestinal tracts; pathogenic for various species of domestic animals and man.

The type species is Brucella melitensis (Hughes) Meyer and Shaw.

## Key to the species of genus Brucella.

- I. Non-motile.
  - A. Grow in special media containing basic fuchsin.
    - Grows in media containing thionin.
       Brucella melilensis.
    - Does not grow in media containing thionin.
  - 2. Brucella abortus.
  - B. Does not grow in media containing basic fuchsin.
    - 1. Grows in media containing thionin.
      - 3. Brucella suis.

II. Motile.

4. Brucella bronchiseptica.

Differential characters of the three closely related species of genus Brucella.

| Species  | Infec-<br>tivity<br>for<br>guinea<br>pigs | Re-<br>guires<br>COy<br>for iso-<br>lation | HS<br>forma-<br>tion         | *Głacose<br>utilized | Amino-<br>nitio-<br>ren<br>utdised | Crowth<br>prese<br>Thin-<br>nin | Basic fuchus |
|--|---|--|------------------------------|----------------------|------------------------------------|---------------------------------|--------------|
| Brucella melitensis , . Brucella abortus Brucella suis | ++<br>++<br>++                            | 10 per<br>cent<br>0<br>++                  | <i>day</i> :<br>±1<br>2<br>4 | +++<br>+<br>+++      | ++++                               | +++<br>0<br>+++                 | +++          |

All utilize glucose in shake cultures.

Brucella melitensis (Hughes)
 Meyer and Shaw. (Bruce, Practitioner,
 1887, 161, tbid., 40, 1888, 241; Rept.
 Army Med. Dept., London, 32, 1890,

Append. No. 4, 465; streplococcus Miletensis (sic) Hughes, The Mediterranean Naturalist, 2, February 1, 1892, 325; Micrococcus melitensis Bruce, Ann. Inst.

<sup>\*</sup> Revised by Prof. I. F. Huddleson, Michigan State College, East Lansing, Michigan, December, 1942.

Past., 7, April, 1893, 289; Hughes, Ja Riforma Med., 5, Aug or Sept, 1893, 789 and Ann. Inst. Past., 7, Aug., 1893, 630, Bacterium meltitense Sassawa, Ztschr f. Hyg. 70, 1912, 181; Neyer and Shaw, Jour Inf. Dis., 27, 1920, 173, Bactillus meltiensis Holland, Jour Bact., 5, 1920, 219; Alcaligenes meltiensis Bergey et al., Manual, 1st ed., 1923, 233, Bruetlus meltensis var. meltiensis Evans, U. S. Public Health. Reports, 38, 1923, 1947.) From Latin, of Malt.

Short ellipsoidal rods, 0 3 to 0 4 micron in length, occurring singly and in pairs, milly in short chains Non-motile Non-acid-fast. Gram-negative

Gelatin colonies. Small, clear, entire. Gelatin stab. Slon growth No liquefaction.

Agar colonies · Small, eircular, convex, amorphous, smooth, glistening, entire, bluish-green, gravish if R type

Agar slant: Growth slow, moist, hone)-like, entire. After a week, the agar is turned brownish and crystals may appear

Broth After 10 days, moderate turbulity and gmyssli sediment. Reaction alkaline, pH 80 or higher.

Litmus milk. Unchanged at 24 hours Later becomes alkaline

Potato Scant growth, grayish becoming brownish.

Indule not formed.

Nitrates reduced, often with complete disappearance of intrite (Zadell and Meyer, Jour Inf Dis, 51, 1932, 99) Because of the latter fact, reports in the literature are apparently contradictors

Animonia produced from area Growth enhanced on beef liver or

tryptose agar of pH 6.8 Neither acid nor gas from carbohy drate

Optimum reaction pH 7 4
Outman temperature 37°C No.

Optimum temperature 37°C No growth at 6° or at 45°C Killed at 50°C Acrobic

Distinctive characters dequires no increased CO<sub>2</sub> tension

Source: Isolated by Bruce (1887, loc. cit ) from the spleen in fatal cases of Malta fever.

Habitat: Chief host the milch goat. The cause of undulant fever (brucellosis) in man and abortion in goats. May infect cows and hogs and be excreted in their milk. Infections for all domestic animals.

2. Brucella abortus (Schmidt and Weis) Meyer and Shan, (Bacillus of abortion, Bang, Ztschr. f. Thermed., 1, 1897, 241; Bacterium abortus Schmidt and Weis, Baktenerne, 1901, 266; Bacterium abortirum Chester, Man. Determ. Bact , 1901, 121 , Corynchaeterium abortus endemic: Preisz, Cent f. Bakt., I Abt , Orig. 33, 1902, 191; Bacellus abortus Evans, Jour Wash Acad Sci., 5, 1915, 122. Meyer and Shaw, Jour. Inf. Dis. 27, 1920, 173, Alcaligence abortus Bergey et al , Manual, 1st ed , 1923, 234; Brucella melitensis var abortus L'anns, l'ublic Health Reports, 58, 1923, 1917 ) From Latin abortus, an untimely hirth.

The morphological and cultural characters are smale to those of Brucella meliters with the following exceptions: Requires 10 per cent CO<sub>2</sub> for isolution, becomes acrobe after several transfers; the browning of the medium in agar skant culture is less marked, S cultures can be differentiated from Brucella military, but not from Brucella mil, but not from Brucella mil, but no from grant properties of the agglutinal absorption test.

Source: From the general organs and milk of infected cattle and from blood in human cases of undulant fever

Halutat. Chief heat the milet cow. The cause of infections aborton in cattle. The same effects are produced in marcs, sheep, rabbats and games pags, and all dorrestic animals except logs. Causis undulant fever (brue llogs) in man

3 Brucella suts Huddleson (Organ ism resembling Bacillus aboutus, Anonymous, U. S. D. A. Ann. Rept. Secy. Dept., Rept. of Chief Rur. Anonal Ind., 1914, 86 (30); authorship established by Traum in North Amer. Vet , 1, No. 2, 1920; described as Bacillus abortus by Good and Smith, Jour. Bact., 1, 1916, 415; Huddleson, Undulant Fever Symposium, Amer. Pub. Health Assoc., (Oct., 1928) 1929, 24; also Mich. Agr. Exp. Sta. Tech. Bull. 100, 1929, 12; Brucella melitensis var. suis Hardy, Jordao, Borts and Hardy, Public Health Reports, 45, 1930, 2433; Bacillus abortus suis Meyer, Amer. Jour. Pub. Health, 21, 1931, 503.) From Latin, of swine.

The morphological and cultural characters are similar to those of Reucella S cultures of Brucella suis can be dif-

melitensis.

ferontiated from S cultures of Brucella melitensis, but not from S cultures of Brucella abortus, by the agglutinin absorption test.

Sourca: From urinogenital and many

other organs of spice.

Habitat: Chief host the hog. Causes abortion in swine and uodulant fever (brucellosis) in man. Also infectious for horses, dogs, cows, monkeys and laboratory animals.

The differentiation of the above species of Brucella by the bacteriostatic action of dyes depends upon the medium used When tryptose agar (Difco) is used, basic fuchsin and thionin should be used

in a final dilution of 1:100,000 There are several forms of the R sod mucoid phases of Brucella spp (Huddleson, Amer. Jour. Vet Res , 7, 1946, 5) The true R type differs from the S type in its lack of pathogenicity, its antigenic properties, its susceptibility to agglutination by exposure of suspensions to heat and to basic dyes in concentration of 1:2000, and colonial appearance. The mucoid phases differ antigenically, morphologically and culturally Colonies on agar are spherical or flat, regular in contour, grayish to mucoid in appearance. Suspensions are not agglutinated by heat or dyes, or always by special

agglutinating serums. There is no chaoge in their growth characteristics on media containing either hasic fuchsin or thionin

4. Brucella broochiseptica (Ferry) Topley and Wilson. (Ferry, Amer. Vet. Rev., 57, 1910, 499; also see McGonan, Jour. Path., 15, 1911, 372; Bacillus bronchicanis Ferry, Jour. Inf. Dis., 8, 1911, 402; Bacillus bronchisepticus Ferry, Amer. Vet. Rev., 41, 1912, 79; Bacterium bronchisepticus Evans, Jour. Inf. Dis., 18, 1916, 578; Bacterium bronchicanis Holland, Jour. Bact., 5, 1920, 221: Alcaligenes bronchisepticus Bergey et al., Manual, 1st ed , 1923, 234; Topley and Wilson, Priocip. Bact. and Immun., 1st ed., 1, 1931, 503.) Latinized, disease of the bronchial tubes.

Evans (loc. cit., 593) regards Bacterium bronchisepticus as related to Bacterium abortus morphologically, culturally, bio-

chemically and serologically.

Short slender rods: 0.4 to 05 by 20 microns, usually occurring singly, sometimes in pairs and chains. Motile with 4 to 6 peritrichous flagella (Topley and Wilson). Gram-orgative.

Gelatin colonies: Similar to those on

Gelatin stab: Slow filiform growth. No houefaction.

Agar colonies: Small, opaque, white, slightly caused, porcellaneous, entire.

Agar slant : Growth moderate but more Invariant than in Brucella melitensis, fillform, slightly raised, smooth, opales. '. - maint antira

> r pellicle dor de-

velops.

Latmus milk: Alkaline. No coagulation.

fairly abundant. Potato Growth brownish, glistening, moist, sticky. Medium is darkened.

Indole not formed.

Nitrates often produced from nitrates (Topley and Wilson).

No acid or gas from glucose, sucrose, lactose, maltose or mannitol.

No H.S produced (Topley and Wilson)
Catalase positive (Topley and Wilson)
Ammonia formed from urea and asparagine,

Optimum temperature 37°C Killed in twenty minutes at 55°C

Aerobic, facultative

Source: From dogs affected with distemper
Habitat Causes acute, often fatal, pregumonia in dogs generally as a second

ary insider in distemper. Also pathogenic for cats, rabbuts, guinea pigs, ferrets, white rats and monkeys. Some times occurs in man.

Appendix: The following are recorded

Appendix: The following are recorded in the literature discussing this genus Brucella etansi Pacheco (Revista de Sociedade Paulista de Med Vet ?

1933, 9) is a name applied to a group of thereton cultures referred to by Evans (Jour. Inf. Dis., 23, 1918, 354) as abortuslike bacteria although she definitely indicates that these cultures do not agree with each other in their blochemical characteristics (loc. cit. Table 4, p. 361).

The binomula Bricella paramelliensis, Brucella parabortus and Brucella parabortus and Brucella parasus have been used for inagglutinable strains of these three species which are, according to Topley and Wilson (Princip. Bact and Immun., 2nd ed., 1936, 632), now known to be merely rough variants, not deserving to be so named

Micrococcus paramelitensis Negré and Raymond (Compt. rend. Soc. Biol., Paris, 72, 1912, 791 and 1952.) Micrococcus pseudomelitensis Sergent

Micrococcus pseudomentensis bergent and Zummitt. 1938 Exact reference not known

## TRIBE III. BACTEROIDEAE TRIB. NOV.

Motile or non-motile rods without endospores. May or may not require enriched culture media. Obligate anaerobes. Gram-negative.

# Key to the genera of tribe Bacteroldese.

I. Cells with rounded ends.

Genus I. Bacteroides, p. 564.

II. Cells with pointed ends.

Genus II. Fusobacterium, p. 581.

#### Genus I. Bacteroides Castellani and Chalmers.\*

(Man. Trop. Med., 3rd ed., 1919, 959.)

Characters as for the tribe. From Greek, like a rod.

The type species is Bacteroides fragilis (Veillon and Zuber) Castellani and Chalmers.

Nore: The descriptions have been taken largely from Weinberg et al. (Lea Microbes Anafrobes, Paris, 1937, 1939; Prévot (Ann. Inst. Past., 60, 1938, 223); Handuney, Ehringer, Urbain, Guillot and Magrou (Diet. Bact. Path. Paris, 1937, 51); and Eggerth and Gagnon (Jour. Bact., 25, 1933, 399). Because cultures of many of these organisms have not been subjected to critical study with identical tests and media, it is difficult to know how many should be considered as distinct species, and the present arrangement must be considered as tentative. The key, of necessity, has been drawn up from recorded characters which appeared useful for the purpose and these on further study may prove to be inadequate.

#### Key to the species of genus Bacteroides.

- Not requiring enriched media.
  - A Gas formed from proteins.
    - Hydrogen sulfide not produced.
      - a Non-motile.

1. Bacteroides fragilis.

as Motile.

2. Bacleroides serpens.

Hydrogen sulfide produced.

a Indole not formed

b. Very pleomorphic.

3. Bacleroides funduliformis.

bb. Not markedly pleomorphic.

4. Bacteroides siccus.

aa Indole formed.

Gelatin liquefied.

Bacteroides coagulans

<sup>\*</sup> Completely revised by Dr. T.E. Roy, Bacteriologist to the Hospital for Sick Claddren, Toronto, Ontario, Canada and Dr. C. D. Kelly, Assistant Professor of Bacteriology, McGill University, Montreal, P. Q., Canada, December, 1938, rearranged, December, 1946.

bb. Gelatin not liquefied.

c. No acid from lactose and maltose. 6. Bacteroides carius.

d. Acid from sucrose. No acid from glycerol. cc. Acid from lactose and maltose-

7. Bacteroides inaequalis. dd No seid from sucrose. Acid from glycerol.

8 Baeleroides insolitus.

B. No gas formed from proteins

1. Indole not formed.

a. Hydrogen sulfide not formed. b No seid from lactose.

bb. Acid from lactose.

e No acut from saliem

ec. Acid from saliein

10. Bacteroides exiguus. 11. Baeteroides uncatus.

9. Bacleroides rescus.

Acid from arabinose. as Hydrogen sulfide formed.

b. No acid from salicin c. Gelatin liquefied

12. Bacteroides rulgatus.

13. Boeteroides incommunis. cc. Gelatin not liquefied. No acid from arrhinose.

14. Bacterordes distasonis. bb. Acid from salicin

bbb. No acid from saliein or arabinose.

15 Boeteroides tumidus. c. Acid from sorbitol 16. Bueteroides conrexus. cc. No acid from sorbitol.

a. No acid from saliein or arabinose 17 Baeleroides aralus 2 Indole formed

as Acid from salicin and arabinose. b. No send from mannitol 18 Bacteroides uniformis.

e No seid from rhamnoso.

19. Bacteroides thetaiotaomicron. ce. Acid from rhumnose d Not capen ated

dd. Capsulated

D. Bacteraides variabilis. 21. Bacteroides gulosus. bb. Acid from mannitol

Il Requiring an enriched medium. A Producing a black pigment.

B Not producing pigment.

n. 1°

Bacterordes melaninogenicus

23. Racteraider carrae.

1. Bacteroldes fragills (Veillon and Castellani and Chalmers. (Bacillus fragilis Veillon and Zuber, Arch. Med. Evp. et Anat. Path., 10, 1898, 870; Castellani and Chalmera. Man. Trop. Med., 3rd ed., 1919, 959; Fusiformis fragilis Topley and Wilson, Princip. Bact. and Immun., 1st ed., 1, 1931, 302; Ristella fragilis Prévot, Ann. Inst. Past., 60, 1938, 290.) . From Latin fragilis, fragile.

Rods with rounded ends, staining more deeply at the poles, occurring singly and in pairs. Non-motile. Gramnccative.

Gelatin: No liquefaction; small amount of gas.

Agar colonies: Small, gray, irregular. Broth: Turbid.

Indolo not formed.

Hydrogen sulfide not formed. Litmus milk: No coagulation. Slight

amount of cas. Nitrites not produced from nitrates. Acid from fructose, maltose, sucrose,

galactose, glucose and arobinose. Some strains produce acid from hetose (Weinberg et al , Les Microbes Anaérobies, 1937, 720).

Anaerobic.

Ontimum temperature 37°C.

Pathogenicity: Some strains produce subcutaneous abscesses in rabbits, guinea pigs or mice.

Source and habitat . From acute appendicitis, pulmonary gangrene, absectses of the urinary tract, and septicaemias in maa.

2. Bacteroldes serpens (Veillon and Zuber) Handuroy et al. (Bacillus serpens Veillon and Zuher, Arch. Med. Exp. et Anat. Path., 10, 1898, 870; Bacillus raditformis Rist and Guillemot, Arch. Med. Exp. et Anat. Path., 1904; Hauduroy et al., Dict. d Bact Path., 1937, 74; Zuberella serpens Prévot, Ann. Inst. Past., 60, 1938, 293.) From Latin serpens, crecping. Rods: Thick, with rounded ends, oc-

curring singly, in pairs, or in short chains. Motile. Gram-negative.

Gelatin: Slow liquefaction, with gas. Agar rolonies: Punctiform.

Deep agar colonies: Small colonies in 48 hours, ray-like growth later. Gas produced.

Broth: Turbid, then flocculent growth: some gas with foul odor.

Hydrogen sulfide not formed

Litmus milk: Acidified and congulated in six days, with no digestion. Acid from fructose, galactose, maltose

and lactose. Congulated egg white and serum not

liquefied. Anacrobic.

Optimum temperature 37°C.

Experimental pathogenicity: stroins produce abscesses in rabbits. guinea pigs and mice.

Source and habitat: Acute appendicitis, mastoiditis, pulmonary gangrene, bile tract of dog, and sea water.

3. Bacteroldes funduliformis (Hallé. Bergcy et al. (Bacillus funduliformi Hallé, Inaug. Diss., Paris, 1898; Bacillus thetoides Rist, Thèso de Paris, 1898; Bergey et al., Manual, 3rd ed., 1930, 373; Spherophorus funduliformis Prévot, Ann. Inst. Past., 60, 1938, 298.) From Latin funduliformis, sausage-shaped.

Rods: 1.5 to 30 microns long in pus, often spindle-shaped. Extremely pleomorphic in culture media, showing irregular filamentous and branching forms. Non-motile. Gram-negative.

Gelatin: Not liquefied.

Deep agar colonies Lenticular, with some gas and foul odor.

Broth: Flocculent growth.

Glucose broth: Rapid growth with gas and foul odor.

Indole not formed; although sometimes found in old cultures. Hydrogen sulfide is formed in small

emounts. Litmus milk: Acid and coagulation by

some strains.

Acid and gas from fructose, glucose and maltose. Some strains ferment mannitol, sucrose and lactose

Anaerobic.

Optimum temperature 37°C.

Experimental pathogenicity. Some strains are pathogenic for rabbits and guinea pigs but not for white rats and muce

Source and habitat: Female genitalia, urmary infections, nuerperal infections, acute appendicitis, otitis, pulmonary gingrene, liver absectes, septicaement and intestinal tract.

i. Bacteroides siccus Eggerthand Gagnon (Eggerthand Gagnon, Jour Bret, 25, 1933, 419, Spherophorus siccus Prévot, Ann Inst Part, 69, 1938, 299) From Latin siccus, dry

Short, thick rods: About 10 meron long. In glucoso broth they are cocoud and often grow in short chains. Non-motile. Gram negative.

Gelatin Not houghed

Blood agar colonies. Flevated, dry, difficult to emulsify, 10 to 15 mm in dumeter

Broth: Granth occurs as a pondery sediment with a clear supernatant fluid Indoic not formed

Hydrogen sulfide is formed

Milk Unchanged.

Attrites not produced from initiales Acad but no gas from fructose. Noncret or gas from glucose, glycend, manutol, sorbitol, arabinose, glycend, manutol, sorbitol, arabinose, glycogen, rham nose, xijos or lictose.

Non-pathogenic for white mice and rabbits

Anaeroliie

Distinctive characters Gas is formed in small amounts from poptone red and brom creed purple are deedouted in most influence broth

Source Two strains isolated from human forces

Habitat: Probably intestinal canel of mammals

5 Bacteroldes coaguians Eggerth and Gagnon. (Eggerth and Gagnon, Jour Bact. £5, 1933, 409; Pasteurella coaguians Prévot, Ann Inst. Past., 60, 1938, 292) From Latin coaguians, coeguiating.

Rods. 0 5 to 2.0 microns long Bipolar staining. Non-mottle. Gram-negative.

Gelatin: Liquefied in S to 12 days. Blood agar colonies Soft, transparent,

05 mm in diameter.

Both - Diffuse crowth.

Indole is formed.

Hydregen sulfide is formed, Milk Congulated in S days without seed production. The congulum partly

redissolves after 3 to 4 weeks.
Nitrites not produced from nitrates.
Non-pathogenic for white mice and

Annerobie.

Distinctive characters. No acid or gesfrom earbohydrates. A small amount of gas is formed from persons. Phenol red and brom cresol purple are decolorized in a meat infusion broth.

Source One strain redated from human feees,

Habitat Probably intestinal canal of maramais.

6 Bacteroldes varius Ergorth and Gagnon (Ergerth and Gagnon, Jour, Bact, 23, 1933, 409, Spherophorus ravius Prévot, Ann Inst Part, 60, 1938, 299.) From Latin carius, diverse. Rods 10 to 30 microns iong Staining

uneven Non-moisle Gram regalise.

Gelatin Not insuefied in 45 days.

Blood agar colonics. Very flat cones, 20 to 30 mm in dismeter.

Broth Diffusely clouded Indole is formed

Hadregen sulfide produced.

Malk. Not acidified or enegulated. Natures not produced from nitrates.

And and gra from fructore, galactose, glucore and manners. No acid or gra from seculin, amplicitin, arabinees, cello-hore, dettrin, glycerol, glycegen, inulin, lattore, maltore, mannitol, melenitase.

raffinose, rhamnose, salicin, sorbitol, starch, sucrose, trchalose or xylose.

Non-pathogenic for white mice and rabbits.

Anaerobic.

Distinctive characters: Gas is formed from peptone. Brom crosol purple and phenol red are decolorized in a meat infusion broth.

Source: Two strains isolated from human feces.

Habitat: Probably intestinal canal of mammals.

 Bacteroldes inaequalls Eggerth and Gagnon. (Eggerth and Gagnon, Jour. Bact, 25, 1933, 407; Spherophorus inaequalus Prévot, Ann. Inst. Past, c0, 1938, 293.) From Latin inaequalus, unequal. Rods. Wide variation in size and form.

Marked pleomorphism on blood agar. Non-motile. Gram-negative.

Von-motile. Gram-negative. Gelatin: Not liquefied in 45 days.

Blood agar colonies: Pin-point in size. Broth Diffusely clouded.

Indole is formed.

Hydrogen sulfide is produced.

Milk: Acidified but not coagulated. Nitrites not produced from nitrates.

Acid but no gas from esculia, amygdalin, arabinose, fructose, galactose, glucose, lactose, matnose, mannose, raffinose, salıcın, sucrose and xylose. No acid or gas from cellobiose, dextrin, glycerol, glycogen, mulin, manniol, melesitose, rhumnose, sorbitol, starch and trebaloso.

Non-pathogenic for white mire and rabbits

Anaerobic.

Distinctive characters: Forms small amount (5 per cent in Smith tube) of gas from neptione water in the complete absence of carbohydrates. None of this gas is absorbed by alfalii. Rapidly decolorizes brom cresol purple and phenol red in meat indixion broth; slowly or not at all in peptone water.

Source One strain isolated from human feces

Habitat: Probably intestinal canal of mammals.

8. Bacteroides Insolitus Eggerth and Gagnon. (Eggerth and Gagnon, Jour. Bact., 25, 1933, 403; Ristella insolida Prévot, Ann. Inst. Past., 60, 1938, 291.) From Latin insolidus, uncommon.

Short thick rods: 1.0 to 2.0 microns long. Often slender, curved, 2.0 to 3.0 microns long. Non-motile. Gramnegative.

Gelatin: Not liquefied in 45 days. Blood agar colonies: Minute, trans-

parent.
Broth: Heavy, diffuse growth.

Indole is formed.

Hydrogen sulfide is formed.

Milk: Acidified and coagulated in 80 to 35 days.

Nitrices not produced from nitrates. Acid but no gas from fruetose, galactose, glucese, glucin, amptalin, arabinose, cellobiose, chatrin, gluceger, inulin, mannitol, meleritose, raffinose, thamnose, salicin, sorbitol, starch, sucrose, trehnlose and xylose.

Non-pathogenic for white mice and

Anaerobic.

Distinctive characters: Brom cresol purple and phenol red are rapidly decolorized in a meat infusion broth. A small amount of gas is formed from peptone.

Source: One strain isolated from human

Habitat: Probably intestinal canal of

9 Bacteroides vescus Eggerth and Gagnon (Eggerth and Gagnon, Jour. Back., 25, 1933, 406; Fusiforms rescus Prévot, Ann. Inst. Past., 60, 1938, 300) From Latin vescus, small or weak.

Slender, pointed rods: 1.0 to 20 microns long, sometimes slightly curved

Bipelar staining, Non-motile Gramnogative

Gelatin Liquefied in S to 25 days
Blood agar colonies. Very numite and
transparent

Broth Diffusely clouded.

Indole not formed.

Hydrogen sulfide not produced Milk Neither acidified nor consulated

Milk Neither acidited nor congulated Nitrites not produced from nitrates Pentone No.228.

Acid but no gris from cellobiose (in 30 days), dextrin, glucose, maliose, mannove and rhatmase. No acid or gris from exculu, amygidin, grabinose, calactose, mannitol, inclezitose, raffinose, sabein, sorbitol, starch, success, trebalose, tybose, glycerol, glycogen, inulin, hetose or fructose.

Non-pathogenic for white mice and mibbits

Anserobie,

Source One strain isolated from hu-

Habitat Probably intestinal can it of

10 Bacteroldes exiguus Eggerth and Griginon (Pagorth and Gagnon, Juni Bret. 25, 1923, 197, Ristella exigua Prévot, Ann Inst. Past., 69, 1938, 292) From Latin exigues, annali and narron

Very small slender rods 05 to 10 micron long, occurring singly and in thurs. Non-mattle. Gram negative

Gelatin Laquefied in 16 to 29 days
Blood agar colonies. These are of two
types. One is puripoint in size, the
other is large, gray, most, 1,0 to 1,5 mm
in dameter.

Broth Diffusely clouded Indole not formed

Hydrogen sulfide not formed

Milk. Acidified and may or may not be congulated in 35 to 40 days

Nutrites not produced from natrates Peptone No gas.

ted but no gas from fruction, gatetion, glucose, bettoe, malton, manness, sucross and trelatore. One strain fer ments raffinose. No acid or gas from esculin, amygdalin, arabinose, cellobiose, devtrin, glycerol, glycogen, indin, mannitol, meleritose, rhamnose, salicin, sorbitol, starch or vylose.

Non-pathogenic for white mire and

Anarmine

Source: Two strains isolated from

Habstat: Probably intestinal canal of mammals.

 Bacteroides uncatus Eggerth and Gegnon (Eggerth and Gegnon, Jour. Bact., 25, 1933, 401; Rutella uncota Prévot, Ann Inst. Past. 60, 1938, 291) From Latin uncutus, hooked at the tip.
 Hods Extreme variations in site and

form The ordinary length is 50 to 80 microns Curved and hooked forms common Non-motific Gram-negative. Gehim: Liquefied in 16 days.

Blood agar colonies Very minute and

transparent
Broth Turbul, growth is slow and

light Indole not formed

\$13 drogen sulfide not formed.

Milk Not neithfield or congulated. Natrates not produced from nitrates.

Pentene No gas

Veil but no gen after 8 to 30 days of inculation from dectrin, fruction, graletore, plurose, lactore, maltice, raffinore, ricamore, salient, starch and sucrose. No acid from cevitin, ampfalin, arabinore, relialione, gly cerol, gly expert, inular, reannual, manners, melestore, sorbatol, trebulses or xylose.

Non-pathogenic for white mice and saldsts

insendae

Source One strain rolated from human

Halatat Probably intestinal canal of mammals

12 Batteroides sulgatus Eggerth and Gegnon (Eggerth and Gegnon, Jour.

Bact., 25, 1933, 401; Pasteurella rulgata Prévot, Ann. Inst. Past., 60, 1933, 292) From Latin vulgatus. common.

Oval rods: 0.7 to 2.5 microns long, usually occurring singly, sometimes in pairs. One strain formed filaments 10 microns long. Stain solidly, some strains show bipolar staining. Morphology very variable in glucose broth.

Non-motile. Gram-negative. Gelatin: Liquefied in 4 to 20 days by all but one strain.

Blood agar colonies: Soft, translucent, grayish, clevated, 1.5 to 2.0 mm in diameter. Half of the strains are hemolytic.

Broth: Heavy and diffuse growth. Indole not formed.

Hydrogen sulfide is formed.

Milk: Acidified. Congulated by some strains in 5 to 25 days.

Nitrtes not produced from nitrates. Acid and a small amount of gas from arabinose, devtrin, fructose, galactose, glucose, glycogen, inulin, lactose, maltose, mannose, raffinose, rhamnose, starch, sucrose and xylese. Seven strains fermented esculin. No acid or gas from amygdafin, cellobiose, glycerol, mannitol, meleratose, salicin, scribiol, trehalose, dulcitol, crythritol or nosstol.

Non-pathogenic for white mice and rabbits.

Ansembic.

Distinctive characters. Does not form indole; does not produce gas from pertone. This is the commonest species found in the feces of adults. Differs from Bacteroides incommunis in that it does not ferment amygdaln and cellobiose, but does ferment glycogen and starch. Liquefices gentin.

Source · Thirty-eight strains isolated from human feces

Habitat: Probably intestinal canal of mammals,

13. Bacteroides incommunis Eggerth and Gagnon. (Eggerth and Gagnon, Jour. Bact., 25, 1933, 402; Ristella incommunis Prévot, Ann. Inst Past., 60, 1938, 291.) From Latin incommunis, not common.

Rods: 0.5 to 1.5 by 1.0 to 3 0 microns, occurring singly. Stain solidly. Nonmotile, Gram-negative.

Gelatin: Not liquefied.

Blood agar colonies: Elevated, slightly yellowish, 1 mm in diameter. One strain formed soft colonies; the other was stringy when emulsified.

Broth: Growth is diffuse.

Indole not formed

Hydrogen sulfide is formed.

Milk: Acidified but not congulated; congulates promptly on boiling.

Nitrites not produced from nitrates.

Peptone: No gas.

Acid and a small amount of gas from

Actd and a small amount of gas from amygdalin, arabinose, cellobiose, dextrin, fructose, galactose, glucose, inulin, lactose, maliose, mannose, rafinose, thamose, sucrose and xylose. One strain fermented glycogen and starch. No action on esculin, glycerol, mannitol, meleritose, salptin, soptiol of trehalose.

melezitose, salicin, sorbitol or trchalose.

Non-pathogenic for white mice and rabbits.

Anzerobic.

Source: Two strains isolated from buman feces.

Habitat: Probably intestinal canal of mammals.

 Bacteroldes distssonis Eggerth and Gagnon. (Eggerth and Gagnon, Jour. Bact., 25, 1933, 403; Rictella distasonis Prévot, Ann. Inst. Past., 60, 1938, 291.)
 Named for Distaso, Roumanian bacteriologist.

Rods: 0 5 to 0.8 by 1.5 to 25 microns, occurring singly. Staining solidly and having rounded ends Some strains show a few bacilli 50 to 80 microns long. Non-motile. Gram-negative.

Gelatin: Not liquefied by 16 strains. The remaining 4 liquefied gelatin in 35 to 50 days.

Blood agar colonies: Soft, grayish, elevated colonies, 1.0 to 1.5 mm in diameter. Two strains markedly hemolytic. Broth: Growth is diffuse Hydrogen sulfide is produced

Indole not formed.

Milk: Acidified. All but 4 atrains coagulate milk. Nitrites not produced from nitrates

Pentone: No gas.

Acid but no gas from amygdalin, cellobiose, dextrin, fructose, galactose, glucose, inulin, lactose, maltose, mannose, melezitose, raffinose, rhamnose. saliein, sucrose, trehalose and xalose Fifteen strains ferment esculin Fifteen strains slowly ferment starch No acid or eas from arabinose, glycogen, glycerol, mannitol or sorbitol.

Non-pathogenic for white mice and rabbita.

Anaerobic.

Distinctive characters: Usually fails to liquely gelatin. Fails to ferment arabinose.

Source. Theaty strains isolated from human feces.

Habitat. Probably intestinal canal of mammals.

15 Bacteroides tumidus Eggerth and Gagnon (Eggerth and Gagnon, Jour. Bact., 25, 1933, 405, Restella lumida Prévot, Ann. Inst. Past . 60, 1938, 292 ) From Latin tumidus, swollen

Small, thick oval reds: 10 to 15 microns long and occurring singly staining is solid. On glucose broth many swollen forms with pregular stamme from 1.0 to 40 by 1.5 to 10 microns The bodies of these swellen forms are usually very rule, with only the ends staining Non-motile Gram negative

Gelatin. Liquefied in 12 to 20 days Blood agar colonies: Soft, graytch,

elevated colonies. I mm in diameter Breth Heavy, diffuse growth

Indote not formed.

Hydrogen sulfide is produced Milk: Acidified but not engulated Nitrates not produced from accretes

Peptone: No gas Acid but to cas from destrin, frur

iose, galaciose, glucose, glycogen, inulia. lactose, maltose, mannose, raffinose, sorbited, starch and sucrose. No acid or gas from esculin, amygdalın, arabinose, reliobiose, giveerol, mannitol, melezitose, rhamnose, salicin, trehalose or xylose,

Non-pathogenic for white mide and rabbits.

A nacrobic.

Source: Your strains isolated from human feces.

Haintat Probably intestinal canal of memmals.

16 Bacteroides convexus Eggerth and Gagnon (l'ggerth and Gagnon, Jour, Bact . 25, 1933, 406 . Pasteurella conreza Prévot, Ann. Inst. Past , 60, 1938, 292.) From Latin concexus, convex.

Thick, oval rods: 08 to 15 microns long, occurring singly or in pairs. In clucuse broth, the rads are usually 20 to 30 microns long Non-motile. Gramavelegan

Gelatin Liquefied in 20 to 30 days Blood ager colonies Elevated, gravish,

somewhat openue colonies, 10 to 15 nim in diameter.

Broth Heavy diffuse growth Indole not formed.

Hydrogen sulfide is produced. Milk Andried and congulated in 4 day s.

Natrates not produced from mirates Pentone No gas

Acid and a small amount of gas from esculta, amygdalan, cellobiose, dextrin, fructose, galactose, glucose, glycogen, mulin, lactore, maltore, mannowe, raffi. nose, starch, sucrose and xylose. No ackl or gas from arabinose, glycerol, margnitol, melevitore, rhampore, salicin, corbatel or trebalose

Non-rathogeme for white mice and ralibite

Anserobie

Source Five strains isolated from human feres

Habitat Probably intestinal canal of mammala,

17. Bacteroides ovatus Eggerth and Gagnon. (Eggerth and Gagnon, Jour. Bact., 25, 1933, 405; Pasteurella ovata Prévot, Ann. Inst. Past., 50, 1938, 292.) From Latin ovatus, egg. shaped.

Small oval rods: 0 5 to 1.0 by 1.0 to 2.0 microns, occurring singly. Stains solidly. Non-motile. Gram-negative.

Gelatin: Liquefied in 4 days.

Blood agar colonies: Soft, grayish, elevated colonies, 1.0 to 1.5 mm in diameter.

Broth: Diffuse, heavy growth.

Indole is formed.
Hydrogen sulfide is produced.

Milk: Acidified and coagulated in 4 days.

Nitrites not produced from nitrates.

Peptone: No gas.

Acid and a small amount of gas from esculin, amygdalin, cellobiose, dextrin, fructose, galactose, glucose, glycogen, inulin, lactose, maltose, mannose, rafinose, rhamnose, starch, sucrose and xylose. No acid or gas from arabinose, glycerol, mannitol, melezitose, solicin, sorbitol or trehalose.

Non-pathogenic for white mice and rabbits.

Anaerobic.

Source. One strain isolated from human feces.

Habitat: Probably intestinal canal of mammals.

 Bacteroides uniformis Eggerth and Gagaon. (Eggerth and Gageon, Jour. Bact, 25, 1933, 400; Rustella uniforms Prévot, Ann Inst. Past., 60, 1938, 201)
 From Latin uniformis, of a single form Small rods; 0.8 to 1.5 microns long,

Stain house to be to minded ends.
Stain heavier at poles and around periphery. Non-motile. Gram-negative
Gelatin Liquefied by two strains in

15 to 40 days. Six strains did not liquely. Blood agar colonies: Transparent, soft, elevated, 0 5 to 0.75 mm in diameter.

Broth: Diffuse growth.

Indole formed.

Hydrogen sulfide produced slowly or not at all. Milk: Acidified and coagulated in 8 to

12 days.
Nitrites not produced from nitrates.

Nitrites not produced from nitrates Peptone: No gas.

Acid but no gas from esculin, amygdalin, arabinose, cellobiose, dextrin, fructose, galactose, glucose, glycogen, inulin, lactose, maltose, mannose, melezitose, raffinose, salicin, starch, sucrose, trehalose and xylose. No acid or gas from glycerol, mannitol, rhamnose, sorbitol, dulcitol, erythriol or inositol.

Non-pathogenic for white mice and rabbits.

Anaerobie.

Distinctive characters. Forms indole. Resembles Bacteroides vulgatus.

Source: Eight strains isolated from human feces.

Habitat: Probably intestinal canal of mammals.

19. Bacteroides thetalotsomicron (Dastaso) Castellani and Chalmers (Bacillus thetaioteomicron Distaso, Cent. Bakt., I Abt., Orig., 62, 1912, 441; Castellani and Chalmers, Man. Trop Med., 3rd ed., 1919, 960; Spherocilus thetaioteomicron Prévot, Ann. Inst. Past., 69, 1938, 300.) The combination thetaiota and omicron is used because the pleomorphic rods have the shape of these Greek letters

Description taken from Distaso (loc. cit.). More complete description will be found in Eggerth and Gagnon (Jour. Bact., 25, 1933, 399).

Short, plamp to oval rods. Stain solidly or only at poles Sometimes with bar causing organism to resemble Greek letter theta. Motile (Distaso). Nonmotile (Eggerth and Gegnon). Gramnegative.

Gelatin. No liquefaction

Glucose agar colonies: Large, transparent, entire Sometimes form gas bubbles

Broth Turbid.

Egg albumen broth Albumen not attacked.

Indole is formed.

Hydrogen sulfide produced (Legerth and Gagnon)

Litmus milk Acid, coagulated Curd shrinks with expulsion of turbed whey

Nitrates not recorded (Distaso) trites not produced from nitrates (Eggerth and Gagnon).

Peptone No gas (Eggerth and Gagnon).

And and gas from esculin, am) gdalin, arabinose, fructose, inulin, lactose, cellohiose, devirin, galactose, glucose, glycogen, maltose, mannose, melezitore, raffinose, rhamnose, sahein, starch, suerose, trebalose and xylose Four strains fall to produce gas from any sugar No acid or gas from glycorol, mannitol or sorbitol (Eggerth and Gagnon)

Appenoble.

Distinctive characters Resembles Bacieroides variabilis but is not cap sulated, does not liquely geletin, usually forms gas from sugars, and ferments melezitore and trelialose Differs from Bacteroides uniformes in morphology. forming gas from sugars and in ferment

ing rhammose (l'ggerth and Gagnon; Source Isolated frequently from human feces

Habitat · Intestinal canal of mammals (common)

20 Bacteroides variabilis (Distant) Castellani and Chrimers (Bacillus carcabilis Distaso, Cent I Bakt, I Abt , Orig , 62, 1912, 4tt, Castellam and Chalmers, Man Trop Med , 3rd ed . 1919, 960, Capsularis iariabilis Prévot, Ann Inst Past, 60, 1938, 293 ) From Laten carrabiles, unriable

Short mids, with munded ends, occur ring singly. Some long flexuous rule Capsulated Non motile Gentu negative

Gelitin No growth on plan gehitm (Distant), hquefaction (Legerth and Gagnon, Jour Bact , 25, 1923 409)

Blood agar colonies: Smooth, ghstening, elevated and very mucoid, about 1.0 mm in diameter.

Broth · Diffuse growth Indole is formed

Hydrogen sulfide is formed.

Latmus milk. Unchanged (Distaso); acidified and some strains coagulating in 25 to 35 days (Eggerth and Gagnon),

Nitrites not produced from nitrates (Eggerth and Gagnon)

l'eptone : No gas.

Acid and gas from glucore, lactore and sucrose (Distaso) Acid and no gas from esculin, amygdalin, arainnose, cello biose, dextrin, fructore, galactose, giscogen, mulin, lactore, glucose, maltose, mannose, raffinose, rhamnose, selacin, starch, sucrose and whose to acid or gir from glycerol, mannitol, melezatore, sorbitol or trebalore (liggerth and Gagnon).

Non nathogenic for white mice and ralshite

Appenduc

Optimum temperature 37°C

Distinctive characters Capsulated. Source Isolated from human feces by Distaso, and by Eggerth and Gignon (5 struns)

Habitat Probably intestinal canal of elemancan

21 Bacteroldes gulosus Legerth and Gagnen (Eggerth and Gagnen, Jour, Bact , 25, 1933, 398, Spherophorus gulosus Prévot, Ann Inst Past , 60, 1978, 298 ) From Latin gulosur, gluttonous

Small oval rods 0.5 to 10 lo 10 to 20 microns, staining deeper around periph-Non-mottle Gram regulage

Geliten Laquefed in 2 to 3 neeks Itherd ager colonies, Soft, gray, entire, elevated, 2 mm in diameter

Broth Heavy and diffuse growth.

Indole form d Halrogen sulfide to formed

Mith Amilfed and congulated in I to A) dase

Vitrites not produced from nutrites

al.

٠k٠

Acid and a very small amount of gas from esculin, amydalin, arabinose, cellobiose, dextrin, fructose, galactose, glycogen, inulin, factose, glycose, malitose, mannitol, mannose, melezitose, raffinose, rhamnose, salicin, sorbitol, starch, sucrose, trehalose and xylose. Sorbitol and mannitol require 2 to 3 weeks for fermentation. Neither acid nor gas from glycerol, dulcitol, erythritol or inositol.

Peptone: No cas.

Non-pathogenic for white mice and rabbits.

Anaerobie.

Source: Seven strains isolated from human feces.

Habitat: Probably intestinal canal of mammals.

22. Bacteroides melaninogenicus (Oliver and Wherry) Roy and Kelly. (Bacterium melaninogenicum Oliver and Wherry, Jour Inf. Dis., 23, 1921, 311; Hemophilus melaninogenicus Bergey et al., Manual, 3rd ed., 1930, 314; Ristella

producing.

Description taken from Oliver and Wherry (loc. cit.) and Burdon (Jour. Inf. Dis., 42, 1928, 161)

Rods: 08 by 10 to 30 microns Non-

motile. Gram-negative. Serum gelatin stab: Dense flocculent

growth at 37°C. No inquefaction.

Blood agar slant: Confluent, black,

dry layer. The blood is disintegrated in one to two weeks forming melanin. The medium becomes colorless.

Sodium phosphate broth Turbid. Litmus milk. Slow scidification but no

coagulation.

Blood serum slant: Fairly luxuriant,
white, moist layer.

Acid from fructose, glucose, lactose, maltose, sucrose and mannitol. No acid from galactose

Non-pathogenic for rabbits, gumes

pigs and white mice (Burdon). Anaerobic.

Optimum temperature 37°C.

Distinctive characters: Growth very poor unless fresh body fluids are added to the medium. Grows more readily in mixed culture. When grown on a medium containing haemoglobin, a black pigment is produced (melanin).

Source: Oral cavity, external genitalia, infected surgical wound, urine and

feces (Oliver and Wherry).

Habitat: Inhabits healthy mucous membranes of mammals, but may take a part in various pathological processes (Burdon).

23. Bacteroldes caviae (Vinzent) Hauduroy et al. (Streptobacillus caviae Vinzent, Ann. Inst. Past., 42, 1928, 533; Hauduroy et al., Dict. d. Bact. Path., 1937, 53; Sphrophorus cariae Prévot, Ann. Inst. Past., 60, 1938, 299.) From Cavia, a genus of rodents.

Rods: Small, sometimes curved. Usurily 0.3 to 0.5 by 1.0 to 1.5 microns. Occurring singly and in chains. Ptomorphic in old cultures with long filamentous forms. Non-motile. Gramnecative.

Serum gelatin: No liquefaction.

Serum agar. Surface colonies, small, translucent, slightly raised, adherent to medium in 48 hours. Deep colonies, lenticular, 2 mm in size in 48 hours. Colonies difficult to break up. No grs. Serum broth: Supernatant fluid clear,

with small, stellate colonies, which tend to adhere to nalls of the tube. No gas.

to adhere to walls of the tube. No gas.

Indole not formed in scrum peptone
water.

Hydrogen sulfide not formed.

Misk. Unchanged.

Congulated egg white and serum not liquefied.

No acid or gas from carbohydrates. Pathogenic for guinea pigs, rabbits and

mice.
Anserobic.

Optimum temperature 37°C.

Distinctive characters: No growth unless serum is added to the medium. Source: From epidemic benign cervical adentits of guinea pigs.

Habitat: Infected guinea pigs so far

Appendix 1: Additional species which may belong here,

Bacteroides laceis (Distaso) Bergey et al (Baailus laceis Distaso, Cent f Bakt., I Abt., Orig., 62, 1912, 441, Berges et al., Manual, 1st ed., 1922, 257, and Bacillus Jacces Frankland and Frank land, Phil. Trans. Roy. Soc. London. 178, B, 1857, 278). From feces

Bacteroides liquefaciens (Distaso) Bergoy et al. (Coccobacillus liquefaciens Distaso, Cent. I. Bakt., I. Abt., Orig., 59, 1911, 102; Bergey et al., Manual, 1st ed., 1923, 202.) From fores

Bacteroides rigidus (Distaso) Bergev et al. (Bacillus rigidus Distaso, Cent f. Bakt., I Abt., Orig. 59, 1911, 101, Bergey et al., Manual, 1st ed., 1923, 223)

Appendix II<sup>2</sup>: Prévot (Ann Inst Inst. 60, 1038, 285 and Man. de Clus et de Déterm. des Bact., Anaérobica, 1910, 38) his armaged some of the anaerobic, pun spore-forming, Gram-negative, burgely parasitie rods in two families. Rettellaceae and Spherophoraceae, as follows

Family Ristellaceae Prévot (Ann. Inst. Past., co., 1938, 288) Genus I., Ristella Privol

(Lee. cit , 289 )

Straight or slightly bent, non mutile rods. Not expaulated. Grain negative Ansemble,

1. Ristella fragilis See Bacteroides fragilis.

- 2. Ristella melaninogenica. See Bacterosdes melaninogenicus.
- 3 Ristella halospitca (Wyssa) Prévot. (Inacterum Myss., Mitt. Grenz Med. u. Clur., 15, 1904, 199; Prevot, loc cr., 291) From a fatal case of osteomy-citus in man. For a description of thus species, see Manual, 5th ed., 1393, 570.
- 4 Installa putedants (Weinberg et al.)
  Prévot (Barillus A, Ileyde, Bestr. 2,
  kin Cherun, 76, 1911, 1; Barillus puteedants Weinberg et al., Les Mierober
  Annérobres, 1937, 785, Prévot, lec. cit.,
  291.) Fuiteen atmins isolated fromarute
  appendientis For a description of this
  species, see Manual, 5th ed., 1939, 571.
- 5 Restella terebrans (Brocard and Pham) Prévot. (Bacullus terebrans Brocard and Pham, Compt. rend Soc. Biol., Paris, 117, 1931, 997; Prévot, loc. ctl., 291) Two strains isolated from cases of grageroous ery spelas, associated with a streptococcus. For a description of this species, see Manual, 6th ed., 1938, 571.
- 6 Ristella furcesa (Veillon and Zuber)
  Prévot (Bacellus furcesus Veillon and
  Zuber, Arch Méd Erp et Anat, Path,
  10, 1898, Fusiforms furcesus Topley
  and Wilson, Princip Bact, and Immun.,
  1st ed., 1, 1931, 392, Bacteroides furcesus
  Hawburg et al., Duct. d. Bact. Path.,
  1937, 63, Prévot, loc ett., 291) From
  exers of appendicties and from lung
  abscresses For a description of this
  species, see Manuel, 5th ed., 1939, 672.
- 7 Rustilla putida (Weinberg et al.). Prévot (Docellus graculta putidus attaser and Martelly, Ann. Inst. Post., 16, 1962, 865, Bactilus putidus Weinberg et al. Les Viernbes Anafenlies, 1937, 700, rot Bactilus putidus Kern, Arb. laks Inst Karlerube, I. Heft 4, 1896,

\* Rearranged by Mrs. Eleanore Herst Chee, New York State Experiment Station, Geneva, New York, December, 1915

- 400; Prévot, loc. cit., 291.) From putrefying meat. For a description of this species, see Manual, 5th ed., 1939, 573.
- S. Ristella clostridiiforms (Ankersmit) Prévot. (Bacterium clostridiiformis Ankersmit, Cent. f. Bakt., I Abt., Orig., 40, 1966, 115; Prévot, Icc. cit., 291.) From the normal intestines of cattle. For a description of this species, see Manual, 5th ed., 1939, 574.
- 9. Ristella perfoctens (Weinberg et al.)
  Prévot. (Coccobacillus anaerobius perfoctens Tissier, Thèse Méd., Paris, 1990;
  Baclerium perfoctens Weinberg et al.,
  Les Microbes Anaérobies, 1937, 790;
  Bacleroides perfoctens Hauduroy et al.,
  Dict. d. Bact. Path., 1937, 67; Prévot,
  loc. cit, 201.) From the intestines of
  infants with diarrhoea. For a description of this species, see Manual, 5th ed.,
  1939, 575.
- Ristella thermophila β (Weinberg et al.) Prévot. (Thermo β, Veillon, Ann. Inst. Past., 36, 1922, 430; Bacullus thermophilus β Weinberg et al., Les Microbes Anaérobies, 1937, 800; Prévot, loc. cit., 201.) From manure. Non-pathogenic.
- II. Riscella thermophila \( \tau \) (Weinborg et al) Provot. (Thermo \( \tau \) Veilon, Ann Inst. Past., 59, 1922, 432, \( Bacillus thermophilus \( \tau \) Weinborg et al, Les Microbes Anadrobies, 1937, 890; Prévot, loc ett., 291) From manure. For \( a \) description of this species, see Manual, 5th ed., 1939, 575
- Ristella incommunis See Bacteroides incommunis.
- Ristella insolita. See Bacteroides insolitus.
- Ristella halosmophila (Baumgartner) Prévot. (Bacleroides halosmophilus Baumgartner Food Research, 2, 1937, 321; Prévot, Man. de Class. et de Déterm.

- des Bact. Anaérobies, 1940, 47.) From salted Mediterranean anchovies. Frequently found in the fish muscle and in the solar salt (the probable infecting agent) in which the fish is packed. For a description of this species, see Manual, 5th ed., 1939, 534.
- Ristella naviformis (Jungano)
   Prévot. (Bacillus naviformis Jungano,
   Compt. rend. Soc. Biol., Paris, 68, 1909.
   122; Prévot, Ann. Inst. Past., 69, 1938,
   201.) From the large intestine of the
   rat. For a description of this species,
   see Manual, 5th ed., 1939, 573.
- Ristella Intents-plant Prévot.
   Gacillus of liehen planus, Jacob and Helmbold, Arch. Derm. Syph., 3, 1933, 23; Prévot, loc. cit., 201.) From the lesions of an inflammatory skin disease, lichen planus.
- 17. Ristella destillationis (Weinberg et al.) Prévot. (Bacterium, Tunnielli, Jour. Inf. Dis., 18, 1913, 283; Bacterium destillationis Weinberg et al., Les Microbes Anaérobies, 1937, 762; Prévot, loc cit., 291.) From a case of chronic bronchitis.
- 18. Ristella uniformis. See Bacte-
- Ristella dislasonis, See Bacleroides distasonis.
- Ristella uncata. Sec Bacteroides uncatus.
- 21 Restella tumida. Sec Bacteroides tumidus.
- 22. Ristella exigua. See Bacteroides exiguus.
- Ristella trichoides (Potez and Compagnon) Prévot. (Bactllus trichoides Potez and Compagnon, Compt. rend. Soc. Biol., Paris, 87, 1922, 339; Bac-

teroides trichoides Hauduroy et al., Dict. d. Bact Path., 1937, 78, Prévot, loc cit, 292.) From a case of cholcocy statis. For a description of this species, see Manual, 5th ed., 1939, 572

- 24. Ristella glutiness (Guillemot and Hallé) Prévot. (Bacillus gétinesus Guillemot and Hallé, Arch Méd L'ty et Anat. Path., 16, 1904, 599, Bacteroides glutinesus Haudurey et al, Diet d Bact. Path., 1937, 61, Prévot, loc est., 292.) From purulent pleurisses
- Ristella capillosa (Tessier) Prévat (Bactilus capillosus Tissier, Ann Inst Past., 22, 1903, 180; Prévat, for est, 292.) From the intestines of infants For a description of this species, see Manual, 5th ed. 1939, 573.
- 20. Ristella sylundroudes (Rocchu) Préota, (Bacterium cylundroudes Rocchu, Lo stato actuale delle nostre enganzona su germi anaerobi Gamberine e Parmer siani, Bolegas, 1908; Prévot, loc cst., 292.) From the human intestine For a description of this species, see Manual, 5th ed., 1939, 574.

## Genus II. Pasteurella Trevisan

Tour species See Bacteroides sul gatus, Hacteroides oralus, Bacteroides contexus, and Bacteroides congularis

Genus III Dialister liergey et al Two species See Dialister

#### Genus IV. Capsularis Prival (Loc. cst., 201)

Characters as for the genus Ristella, but capsulated.

1. Capsularis 2009leiformans (Meinberg et al.) Prévot (Baeillus murosus anaerobius Prusmits, Cent f. Baht. I. Abt., Orig., 59, 1922, 125, Backersum 2009leiformans Weinlerg et al., Les Microbes Amérobies, 1937, 725; Bacteroides prauseniteit Handuroy et al, Duet d. Bact. Path., 1937, 68; Prévot, Ioc cit., 293 ) From a purulent emptema in man. For a description of this species, see Manual, 5th ed., 1939, 576.

- 2 Capsularis mucosus (Weinberg et al.) Prévot. (Coccobacterium mucosum amacrobicum Klinger, Cent. f. Bakt, f. Mit., Orig., 62, 1912, 180; Bacterium mucosum Weinberg et al., Lea Microbes Anaérobics, 1937, 727, Bacteroides riscosum Haudmoy et al., Dict. d., Bact Path, 1937, 81; Prévot., for ett., 293.) From a brain abscess following branchicetasis an man. For a description of this species, see Manual, 5th ed., 1939, 525.
- 3 Capsularis variabilis Sec Bacteroides variabilis

#### Genus l' Zuberella Prerot,

(Loc ett, 200)
Characters as for the genus Restella.

but mottle with peritrichous flagella.

- 1 Zuberella serpens. See Bacteroldes serpens
  - 2 Zuberella procesula (Presser) Prévot (Coccobacillus praencius Te-ner, Ann Inst Part, 22, 1908, 180; Prévot, Ice est, 293) From the intestines of infants. For a description of this species, see Manual, 5th ed., 1979, 577.
- 3 Zubreilla clottishiforms mobilis Prévat (Meterium clatificiforms, Chouléisteh, Ann Inst Part, 15, 191, 315, Prévat, loc ett. 231) From the intestines of abora. Chouléisteh considered his organism the same as Ankersmit's Botterium clottishiforms, although the former was motile.
- 4 Zuberella aquatidis Privot (Spray and Laux, Amer Water Works Area

22, 1930, 235; Prévot, loc. cit., 293) From river water. For a description of this organism, see Manual, 5th ed., 1939, 577.

5 Zuberella variegata (Distaso) Prévot. (Bacillus iarregatus Distaso, Cent. f. Bakt., I Abt., Orig., 62, 1912, 445; Bacteroides rariegatus Castellani and Chalmers, Man. Trop. Med., 3rd ed, 1919, 960; Prévot, loc. cit., 293.) From the intestines. For a description of this species, see Manual, 5th ed., 1939, 578.

6. Zuberella rhinitis (Tunnicijif) Prévot. (Bacıllus rhinitis Tunnicijif, Jour. Inf. Dis., 16, 1913, 493; Prévot, Ioc. cit., 293.) Thirty-two strains isolated from the nasopharynx in human beings suffering from pharyngitis, tansilitis, bronchitla and rhinitis, as well as from the nasal muccoa of normal human beings, rabbits, guinea pigs and dogs. For a description of this species, see Manual, 5th ed., 1939, 576.

Family Spherophoraceae Prévot.

(Loc. cit., 289.)

Genus I. Spherophorus Prérot.

(Loc. cit., 297.)

Very pleomorphic rods, Metachromatic granules common in clongated forms. Non-motile. Non-spore-forming, Gram-negative.

1. Spherophorus necrophorus (Flugge)
Prévot. (Bacillus der Kalberdiphtherie, Loeffier, Mittell. kaiserl. Gesundheltsamte, 2, 1884, 493; Bearllus
diphtheriae vitulorum Flugge, Die Mikroorganismen, 2 Aufl., 1886, 265; Beacillus
necrophorus Flugge, ibid, 273, Beacillus
necrophorus Flugge, ibid, 273, Beacillus
netrophorus Flugge, ibid, 273, Beacillus
netrophorus Flugge, ibid, 278, Beacillus
netrophorus Flugge, ibid, 278, Beacillus
netrophorus Flugge, ibid, 278, Beacillus
filiformis This, Ztschr. f. Hyg, 9, 1800,
241; not Bacillus filiformis Migula, Syst.

d. Bakt., 2, 1900, 587; Nekrosebacillen,

nomyces cuniculi Gasperini, Mittheil. 11 Internat. Med. Congr. Rome, see Cent. f. Bakt., 15, 1894, 684; not Actinomyccs cuniculi Erikson, Med. Res. Council Spec. Rept. Ser. 203, 1935, 32; Oospora diphtheriae ritulorum Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2. 1896, 393; Actinomyces necrophorus Lehmann and Neumann, Bakt. Diag., 2 Aufl., 2, 1899, 434; Streptothrix necrophora Kitt, Bakterienkunde, 1899; Corynebacterium necrophorum Lehmann and Neumann, Bakt. Diag., 4 Aufl., 2, 1907. 531: Bacillus necroseos Salomonsen. quoted from Lehmann and Neumann, ibid., 532: Cladothriz cuniculi Macé. Traité de Bact., 6th ed., 2, 1913, 753; Bacterium necrophorum Lehmann and Neumann, Bakt. Diag., 7 Aufl , 2, 1927, 504; Fusiformis necrophorus Topley and Wilson, Princip. Bact. and Immun , 1st ed., 1, 1931, 299; Prévot, Ann. Inst. Past., 60, 1933, 293.) Because of the importance of this organism, a description is included here:

Rods: 0.5 to 1.5 microns wide, forming long filaments, up to 80 to 100 microns long. Some authors report branching, others deny this. Short forms are reported by Schmorl to be motile. Gramnegative.

Gelatin stab: No liquefaction.

Agar colonies: Small, dirty-white, circular, opaque, with yellowish center under low power lens. Margin floccose.

under low power lens. Margin floccose.

Agar stab: Yellowish colonies along
needle track. Gas bubbles produced.

Coagulated blood serum: Small, whitish colonies, becoming opaque, fimbriste. Broth: Turbid, with gas. Cheese-like

Indole is formed.

Litmus milk: Cheese-like odor. Acidified and generally coagulated.

Nitrites not produced from nitrates.

Amerobic.

Optimum temperature 37°C.

Produces a soluble exctoxin.

Source and habitat: Causes diphthera in cattle with multiple sclerotic abscesses; gangrenous dermatitis in horses and mules; multiple necrotic foci in liver of cattle and hogs. One case of human infection reported. Transmissible to mice and rabbits

- 2. Spherophorus funduliformis See Bacteroides funduliformis
- 3. Spherophorus necrogenes (Weinberg et al.) Prévot. (Bacillus, Kanamura, Jour. Jap. Soc. Vet. Sci 5, 1926, 22: Bacillus necrogenes Weinberg et al , Les Microbes Anaérobies, 1937, 381, Prévot, loc. cit., 298.) From epidemie abscesses in hens.
- 4. Spherophorus necrolicus (Nativeile) Prévot (Bacillus necroticus Nativelle, 1936, see Weinberg et al , Les Microbes Anaérobies, 1937, 693, Préset. loc. cit , 209.) From a case of gangrenous appendicitis. For a description of this species, see Manual, 5th ed , 1939, 580
- 5. Spherophorus perstonitis Prévot. (Bacillus, Ghon and Sachs, Cent Bakt., I Abt., Orig., 53, 1905, 1 and 131, Prévot, loc. cit , 298 ) From personnal exudate.
- 6 Spherophorus gulosus See Bacteroides gulasus.
- 7 Spheraphorus inaequalis bee Bac teroides enaequalis.
- 8. Spherophorus rarius See Bac

terorder rarius.

- 9. Spherophorus siecus See Bacterordes steeus.
- 10. Spherophorus morteferus (Harris) Prevot. (Bocillus mortiferus Harris, Jour Evp Med , 6, 1901, 519; Prévot.

- loc. cit , 200.) From a liver abseess in man For a description of this species, see Manual, 5th ed., 1939, 581.
- 11. Spherophorus freundi (Hauduroy et al ) Prévot. (Freund, Cent. f Bakt., I Abt . Ong , 88, 1922. 9; Bacterium of Preund, Weinberg et al , les Microles Anaérobies, 1937. 706; Bacteroides freunder Hauduroy et al , Diet. d Bact, Path., 1937, 57, Prévot, loc est . 299 ) From a nurulent memngitis following otitis in man For a description of this species. see Manual, 5th ed , 1939, 581.
- 12 Spherophorus pyogenes (Hauduroy et al ) Prévot (Buday, Cont. f. Bakt , I Abt , Orig , 77, 1916, 453, Bacil. lus pyogenes anacrobius Bela-Johan. Cent f Bakt., I Abt., Orig , 87, 1922, 200; Bacterordes pyogenes Hauduray et al., Dect d Bact Path , 1937, 69, Prevot. toc. cit, 293) From abscesses of the liver and lungs following septic war sounds Also from the blood stream following tonsillectomies I'or a description of this species, see Manual, 5th ed., 1939, 582.
- 13 Spherophorus gonidiaformans (Tunnieliff and Jackson) Prevot. (Bacellus gonedeaformans Tunniclell and Jickson, Jour Inf Dis , 20, 1925, 430, Actinumyces canadiforms (sie) Bergey et al , Manual, 3rd ed , 1930, 469, Hacterendes gansdiaformans Handarov et al . Dict d Bact Path , 1937, 62, Prévot. loc cet, 299 ) From a tonal For a description of this species, see Manual, 5th ed , 1939, 582
- 14 Spherophorus flocensus (Weinlerg et al ) Prevut (Streptobacellus progenes floressus Commont and Cade, Arch. Med Exp. 12, 1900, 303, Bacillus foc. cosus Besnberg et al , Les Microles Ansember, 1937, 698, not Recellus forcesus hern, Arb lakt last, Ketlerul e, 1, Heft 4, 1996, 421, Becteroifes foerorus Handumy et al , Diet d Bact

Path., 1937, 55; Prévot, loc. cit., 299.) From blood in pyemia of man. For a description of this species, see Manual, 5th ed., 1939, 580.

15. Spherophorus influenzaeformia (Russ) Prévot. (Bacillus influenzaeformis Iluss, Cent. f. Bakt., I Abt., Orig., 39, 1995, 357; Bacteroides russii Hauduroy et al., Diet. d. Bact. Path., 1937, 73; Prévot, lac. cit., 299.) One strain isolated from a perianal nbscess and two strains from purulent meningitis in man. For a description of this species, see Manual, 5th ed., 1939, 553.

16. Spherophorus cariae, See Bacteroides cariae

Genus II. Spherocillus Prévot.

(Loc. cit., 297.)

Characters as for the genus Spherophorus, but motile with peritrichous fluxella.

- 1. Spherocillus bullosus (Distaso) Prévot. (Bacillus bullosus Distaso, Cent. I. Batt. I. Abt., Org., 62, 1912, 443; Bacteroides bullosus Castellani and Chalmers, Man Trop. Med., 3rd ed., 1919, 960; Prévot, loc cit, 300) From the mestinal canal For a description of this species, see Manual, 5th ed., 1939, 583
  - 2. Spherocillus thetaiolaomieron See Bacteroides thetaiolaomieron
- Spherocillus wirth Prévot. (Bacillus, Wirth, Cent f. Bakt, I Abt., Orig, 105, 1928, 201, Prévot, loc cit., 300.)
   From a case of acute otitis.

Appendix III: The following additional species have been found in the literature.

Actinomyces pseudonecrophorus Harris and Brown (Bull Johns Hopkins Hosp.,

40, 1927, 203.) From the uterus in cases of puerperal infection. Probably should be classified near Spherophorus. For a description of this species, see Manual, 5th ed., 1939, 579.

Bacillus anaerobius gracilis Lewkowicz. (Arch. Med. Exp., 18, 1901, 633.)

From the mouths of infants.

Bacillus angulosus Garnier and Simon (Presse Méd., 1909, 473.) From the blood of an infant with typhoid fever,

Bacillus annuliformans Massini. (Ztschr. f. gesam. Exp. Med., 1913, 81.) From a tuberculous cavity of man. Pathogenic.

Bacillus circularis major Heudin. (Bakt. Unters. d. Keimgehaltes im Genitalkanale d. fiebernden Wechnerinnen. Helsingfors, 1910, 168.) From the genital canal. Anserobie. Gram-negative.

Bacillus limitans Heurlin. (Ibid, 165.) From the genital canal. Anaero-

bie. Gram-negativo.

Bacillus nebulosus Hallé. (Hallé, Thèse de Paris, 1898; not Bacillus nebulosus Vincent, Ann. Inst. Past., 21, 1907, 69.) From the human vagins.

Bacillus siellatus Vincent, (Vincent, Ann. Inst. Past., 21, 1907, 62; not Bacillus siellatus Chester, Man. Determ. Bact., 1901, 274.) From water.

Bacillus symbiophiles Shottmuller. (Leitfaden f. d. klin. bakt. Kultur., Berlin, 1923.) From the blood in a case of puerperal fever.

Bacterium albarrani Jungano. (Compt. rend Soc. Biol., Paris, 63, 1907, 302.)

From a case of cystitis.

Bacterium minultsimum Le Blaye and Guggenheim. (Cocco-bacillus minutssimum gazogenes Jacobson, Ann. Inst. Past., 22, 1903, 300; Le Blaye and Guggenheim, Manuel Pratique de Diagnosta Bact, Vigot Frères, 1914.) From intestines of infants.

Bacteroides splenomegaliae (Pinoy) Hauduroy et al. (Synbacterium splenomegaliae Pinoy, Compt. rend. Acad. Sci., Paris, 183, 1926, 1429; Hauduroy et al., Dict. d. Bact. Path., 1937, 75.) From cases of splenomegaly in Algeria Pathogenic.

Pasteurella anaerobiontica Levinthal (Cent. f. Bakt., I Abt , Ong , 106, 1928, 195.) From the naso-pharyny of man

Streptabacillus gracilis Guillemot and Hallé. (Guillemot and Hallé, Arch Méd Exp et Anat Path , 16, 1901, 598. Bacteroides streptishacilliformis Hauduroy et al , Diet d Biet Path , 1937, 76 ) From putrid plcurisies.

#### Genus II. Fusobacterium Knorr.

(Knorr, Cent. f. Bakt., I Abt., Orig., 87, 1922, 536, Fusiformis Prévot and Fusocillus Prevot, Ann. Inst. Past . 60, 1938, 300.)

Gram-negative, anaerobic rods, usually with tapering ends. Usually non-motile Stain with more or less distinct granules Key to the species of genus Fusabacterium.

The type species is l'usobactereum plaute rencente Knorr

- I Acid from maltose
  - A No gas produced
    - B. Gas produced
- II. No need from maltose

  - B No odor produced
  - A. Disagrecable odor produced on cultivation 3 Fusobacterium nucleatum.
- 1. Fusobacterium plauti-vincenti Knorr, (Knorr, Cent f. Bakt , I tht . Orig., 89, 1923, 16; Fusiformie plauti eineenti and Fusiformis eineenti Haudu roy et al Diet d. Bact Path , 1937, 210 ) Named for H C Plant and for H Vincent who studied diseases of the respirators tract.

The relationships between this organ ism and the following have not been clearly established Furiforms dentium Hoelling, Arch. f Protestenkunds 19, 1910, 210, Hacillus fustforms Veillon and Zuber, Arch do med exper to 1898, 517 (Corynchaeterium funforms Lehmann and Neumann, Bakt Ding , 4 1uff . 2, 1907, 529), not Bacillus fuer formie Gottheil, Cent f Bikt , H Mit , 7. 1901, 721; Fuerformie funiformie Topley and Wilson, Princip of Bact and Immun , let ed , 1, 1931, 500

Microbes Analymbies, 1937, 801) and

Weinberg, Nativelle and Privot des

- 1 I usobacterium plauti eincents
- 2 Fusobactersum biacutum
- 4 Fusobacterium polymorphum

Prevot (Ann. Inst. Past., 60, 1938, 285) make a distinction between Plant's hardlus (Fusnerllus plants) and Vincont's bueillus (Fuerfarmes fusiformes). the former being actively mutile and nonput logetue and the litter non moule and test largemer

Rode 05 to 10 by 8 to 16 rarme, securing in pure with blunt ends together and outer ends pointed, son etimes in short, curved chains or long spiritum. the threads Granules present Nonnotife Grant negotice

Serom egar sleake rulture. Mier 36 hours, edonies splanical, up to 95 min in chameter than, a Borash brown

berum sger plate. Matted growth Medium around colomes becomes turbed form the precipitation of protein. No

surface growth serum broth Milks turladity

Laver broth No turbidity Gravistic white, faks precipitate

\* Arranged by Prof. Robert S. Breed, New York State I aprilliant Station, General New York, December, 1938, rearranged, December, 1945

#### TRIBE IV. HEMOPHILEAE WINSLOW ET AL.

(Jour. Bact., 5, 1929, 212.)

Minute parasitic forms growing on first isolation only in the presence of hemoglobia. ascitic fluid or other body fluids, or in the presence of certain growth accessory substances found in sterile, unheated plant tissue (potato). Motile or non-motile. Commonly found in the mucosa of respiratory tract or conjunctiva.

#### Key to the genera of tribe Hemophilese.

- I. Aerobes to facultative anacrobes.
  - A. Non-motile.
    - 1. Predominantly occurring singly.
    - Genus I. Hemophilus, p. 584. Predominantly occurring as diplobacilli.
  - B. Motile, encapsulated.

Genus II. Morazella, p. 500. Genus III. Noguchia, p. 592.

II. Annerobes.

A. Non-motile.

Genus IV. Dialister, p. 594.

## Genus I. Hemophilus Winslow et al.\*

(Jour Bact, 2, 1917, 561.) From Greek, loving blood.

Minute rod-shaped cells, sometimes thread-forming and pleomorphic. Non-motile. Strict manaites growing best (or only) in the presence of hemoglobin and in general requiring blood serum, ascitic fluid, or certain growth accessory substances

The type species is Hemophilus influenzae (Lehmann and Neumann) Winslow et al.

## Key to the species of genus Hemophilus.

I. Affecting the respiratory tract

1 Require both V and X growth factors for growth.

- 1. Hemophilus influensae.
- 2. Hemophilus suis.
- 3. Hemophilus hemolyticus
- 2 V growth factor sufficient for growth.
  - 4 Hemophilus parainfluenzae.
  - 5. Hemophilus pertussis.
- II. Affecting the genital region.
- 3 X growth factor sufficient for growth.
  - 6. Hemophilus ducrevi
  - 7. Hemophilus hacmoglobinophilus.

<sup>\*</sup> Revised by Dr. Margaret Pittman, National Institute of Health, Bethesda, Maryland, October, 1945

Where the relationship to growth accessory factors as known, the following table may serve as a key:

|                               | -             |  |                |
|-------------------------------|---------------|--|----------------|
|                               | Growth        | conta n ng                             |                |
| Species                       | Growth factor | Phospho<br>pyridine mi<br>cleatele (V) | Growth factors |
| Hemophilus influenzae         | -             | -                                      | ' <del>+</del> |
| Hemophilus surs               | -             | ! -                                    | 1 +            |
| Hemophilus hemolyticus        | -             | ±                                      | +              |
| Hemophilus parainfluenzae     | -             | +                                      | , +            |
| Hemophilus haemoglobinophilus | +             | ,                                      | +              |

3 Hemophilus influenzae (Lehmann and Neumann) Winslow et al (Koch, Wiener med. Wehnschr , 33, 1883, 1550, Weeks, New York Med Record, 31, 1887, 571; Influenzabacillus, Pfeiffer, Deutsche med, Weimschr, 1872, 28, Zischr f Hyg , 15, 1803, 357 , Bacterrum influenzae Lehmann and Neumann, Hakt Ding., 1 Aufl., 2, 1896, 187, Barillus influenzae Kruse, in Flügge, Die Mikm organismen, 3 Auff , 2, 1896, 431, Bac terium aegyptiacum Lehmann and Neumann, Bakt Diag , 2 Aufl , 2, 1899, 191. Hemophilus meningitidis cerebro apinglia septicemiae Coben, Ann Inst. Past , 25, 1909, 273, Winslow et al , Jour Bart , 2, 1917, 561, Coccobacellus pfeiffert Neveu-Lemaire, Précis Paran tol Hum , 5th ed , 1921, 20, Hemophilus conjunctivitidis Bergey et al., Manual, 1st ed , 1923, 270 ) From influenza, n disease of the respiratory tract

Common name The Rock-Weeks

Very small rods 0.2 to 0.3 by 0.5 to 2.6 merons, occurring unigly and in pairs, occasionally in short cleans, and at times long thread forms are seen. Frequently show a marked tendency to hypotr staming. Some strains are encapsulated Non-motile Gram negative.

Requires both the factors X and Y for its growth

Gelatin colonies. No growth Gelatin stab. No growth

,

Blood ages colonies Small, circular, transparent, homogeneous, entire Sitellitism with Staphulococcus

Blood ager slint. Thin, filiform, transparent growth

Checofite agre shit Luxument

growth Blood broth Sightly turbed No

hemolysis
Litmus milk, with blood. Some strains

render it very slightly alkaline Steribzed potato slant. No growth

Fresh unheated sterile potato added to broth favors development

Indole is formed by some strains

Nitries are produced from nutries. Some eterns attack more of the carbohydrates, while other strains attack various carbohydrates, provided a suitable medium is used. Manufol and lactors never fermented.

Pathogenic

tembre, facultative

Optimum temperature 37°C Maximum 47°C Minimum 26° to 27°C Killed at 57°C for thirty minutes

Source Isolated by Pfeifler in cases of influence. I cand an conjunctive, nose plainties, spatian, station, cerebrespixed fland, blood, and puts from gants.

Helatet Respirators track A came of acute respirators infections, of acute conjunctivities, and of parulent is energine of children parels of adults. Re-

short chains. Non-motile. Gramnegative.

Requires the X factor for its growth.

Blood agar colonies: Small, clear, transparent, entire. Old colonies become opaque.

Blood broth: Turbid.

Blood milk mixture: Doubtful development.

Indole is formed.

Nitrites produced from nitrates.

Acid but no gas from glucose, fruetose, galactose, mannitol, sucrose and xylose. No acid from maltose, lactose dextrin, arabinose or glycerol. (Rivers, loc. cit.)

Optimum temperature 37°C. Aerobic, facultative.

Habitat: Occurs in large numbers in proputial secretions of dogs.

Appendix I.\* The following species has been placed in the tribe Hemphileae by Yan Rooyen (Jour. Fath and Bact., 43, 1036, 460). It has been pointed out by Buchanan (General Systematic Bacteriology, 1925, 490) that the genus name Streptobacillus is invalid.

Streptobacilius moniliformis Levaditi, Nicolau and Poineloux (Compt. rend. Acad. Sci., Paris, 180, 1925, 1188.)

This organism is regarded as identical with Haverhillia multiformis Parker and Hudson (Amer Jour. Path., 2, 1926, 357) by Van Rooyen (loc cit ). Topley and Wilson (Princip, Bact, and Immun., 2nd ed., 1936, 270) regard it as identical with their Actinomyces muris (Streptothrix ratti Schottmuller), the cause of rat-bite fever. Asterococcus muris Heilman, Jour, Inf Dis , 69, 1941, 32. See Actinomyces muris ratti in the Appendix to the genus Streptomyces. Jordan and Burrows (Textb of Bact , 14th ed , 1946, 614) consider all these names synonymous. Dawson and Hobby (Proceedings, Third Internat Congr. for Microbiol., New York, 1940, Section I, 177) suggest that the pleuropneumonia-like cultures isolated from Streptobacillus montiformia really represent variant phases in the growth of this organism,

Description from Levaditi et al. (loc. cit.) and Brown and Nunemaker (Bull. Johns Hopkins Hosp., 70, 1942, 201).

Streptobaeilli; 2.0 to 3.0 microns in length, pleomorphie, with branching filaments up to 30 to 40 microns long, fragmented, bacillary and coccobacillary forms. Swollen and elub-shaped cells are found. Morphology is best demonstrated by aniline dyes, e.g. Wayson's plague stain. Non-motile. Gram-negative.

Enriched media are required for good growth. Best liquid media are rabbit blood and broth containing serum or ascitic fluid. Best solid media are glycerol extract of potato-infusion broth-egg yolk medium and nutrient agar containing serum.

Blood agar or ascitic serum agar: Colonies small, clear.

Blood plates: Growth slow. Numerous small whitish colonies appear on the third day.

Veillon's medium; Punctiform colonies, abundant in depth, less growth at surface. No was.

Broth with a scitic fluid and globular extract: Good growth, forming clots which precipitate and are rather acherent to one another. Growth rapidly reduces the pH of the medium killing the bacteria in cultures 24 hrs. old.

Milk: Slow growth. No coagulation Loffler's serum: Poor growth

Virulent for rabbits and mice.

Good growth at 37°C.

Facultative anaerobe. Grows better under anaerobic conditions in the presence of added CO<sub>2</sub>, than in the presence of air.

Source: Isolated from a case of a febrile,

<sup>\*</sup> Appendixes I and II arranged by Prof. E. G. D. Murray, McGill Univ., Montreal, P. Q., Canada, March, 1946.

septicemie disease, accompanied by artbritis, crythema and angina.

Habitat: The cause of an acute febrile disease sometimes called crythema multiforme

Appendix 11: The following species may be identical with some of those listed above or related to them

Bacillus marianensis Leber and Prowazek. (Berlin, khn. Wochnschr, 1, 1911, 27) Allied to the Koch-Weeks Bacillus Associated with cases of pink cyc.

Bacillus weeksi Neveu-Lemare (Précis Farantol, Ilum, 5th ed., 1921, 21) Desembed by Weeks. The cause of trachoma or granulur conjunctivitis in tropical countries. Transmitted by the domestic fly. Probably intended for the Week's bacillus (Weeks, New York Med Record, 37, 1857, 571)

Batterium lussis conculuide Lehmann and Neumann. (Bacterium, Czaplewski and Hensel, Deut med Wochneler, 23, 1877, 587, Lehmann and Neumann, Bakt Dag, 2 Aufl, 2, 1899, 192; not Bacterium lussis conculsione Lehmann and Neumann, ibid, 7 Aufl, 2, 1927, 317, Bacillus lussis conculsione Lehmann and Neumann, ibid, 4 Aufl, 2, 1907, 269) Consulered the cause of wheoming count by the correlative States.

Hemophilus aphrophilus Khurat (Jour Path and Bret , 50, 1940, 497) From blood and from heart valve of a case of endocarditis

Hemophilus cuniculi Haudinroy et al (Hemophilus sp Gibbans, Jour Inf Dis., 45, 1929, 288, Haudinroy et al., Diet d Bact Path., 1937, 249.) From skin abscusses of rabbits

Hemophius gallinarum Delaphane, Er man di Stuart and Hemophius gallinarum Ehotand Lewis (Hacillus kemo globinophilus corgiae gallinarum De Black, Tiplsch v Diergeneensk, 88, 1931, 310, alon see Vet Jour, 88, 1932, 9, Delaplane, Erwin and Stuart, R. I. State Coll. Sta. Bull. 214, May, 1931, Elnot and Lewis, Jour. Amer. Vet. Med. Assoc., 84, 1934, 578.) From edematous fluid from the head of a chieken. The cause of an infectious rhinitis in chickens.

Hemophilus influenciae murium (kairies and Schwartzer) Iawoff. (Bacterum influenciae murium Kairies and Schwartzer, Cent. I. Bakt., I Abt., Orig., 137, 1936, 351; Worff, Ann. Inst. Past., 62, 1939, 163.) From the lung of a mouse.

Hemophilus meningitadis (Martins) Hauduroy et al. (Coccobacillus meningitadis Martins, Compt rend. Soc. Biol., Paris, 99, 1928, 935; Hauduroy et al., Diet. d Bate Path, 1937, 251.) ite-embles Hemophilus influenzae overpt that it shows sluggish motility. From cerebro-spinal fluid.

Hemophilus muria Hauduroy et al (Bacillus of an epiziotic of stock timee, Mackie, Van Rooyne and Gilroy, Brit. Jour Exp Path, 14, 1933, 132, Hauduroy et al., Diet d. Bact Path., 1937, 235.) From heart blood, spleen and other organs of mice dying from an epiziotic disease.

Hemophifus ous Mitchell. (Jour. Amer. Vet Assoc, 68, 1925, 8.) From bronchi of sheep

Hemophilus pertusus Ford (Hearthus pertusus expended Johennan and Krause, Zisela I Hyg., 35, 194, 193; Ford, Texth of Bact., 1927, 615; not necessarily identical with Forder and Gengui's organism, Hemophilus pertusus Holland, Jour Bect. 5, 1920, 215). From the respiratory tract and lurgs in pertusus.

Hemophilus pitoriorum Handuroy et al. (Bacterium influeniae putriforum multiforne Kairies, Zischi, f. Hyg., 117, 1935, 12, Handurov et al., Diet, d. Bret Path., 1937, 235.) From the respiratory tract of ferrets.

Lehmann and Neumann (Bakt Dog., 6 Aufl., 2, 1929, and 7 Aufl., 2, 1927) list the following species as closely related to this group:

Bacillus catarrhalis Jundell. (Hygieae, 60, No. 6 and 7, p. 667.) From cases of neute bronchitis.

Bacillus trachomatis Lehmann and Neumann. (The Bacillus Müller, Luerssen, Cent. f. Bakt., I Abt., Orig., \$9, 1905, 682.) From conjunctiva.

Bacterum exapteuski: Chester. (Bacillus bei Keuchhusten, Cxaptewski, Cent. f. Bakt., 22, 1837, 641; Bacterium lussis convulsivae Lehmann and Neumann, Bact. Diag., 2 Aufl., 1899, 192; Chester, Man. Determ. Bact., 1901, 153.) From sputum in whooping cough. This is not now regarded as being etiologically associated with whooping cough cally associated with whooping cough.

med. Wehnschr., No. 45, 1905.) From a case of septic endocarditis.

Bacterium microbutyricum Hellstein.

Bacterium minutissimus sputi (Luzzatto) Lehmann and Neumann. (Bacillus minutissimus sputi Luzzatto, Cent. f. Bakt, I Abt., 27, 1900, 816) From a case of pertussis.

Bacterium polymorphum convulsivum Melfi. (Cent. f. d. gesamte Hygiene, 7, 1924, 133)

Bacterium septicaemiae canis Paranhos. (Cent. f. Bakt., I Abt., Orig., 50, 1909, 607.)

Streptobacillus urethrae Pleiser. (Cent. f. Bakt., I Abt., Ref., 55, 1905, 59.) From the normal urethra and from cases of chronic cystitis and urethrits.

#### Genus II. Marazella Luoff.\*

(Diplobacillus McNab, Klinische Monatsbl. f. Augenheilk., 42, 1904, 64; not Diplobacillus Weichselbaum, Cent. f. Bakt., 2, 1837, 212; Lwoff, Ann. Inst. Past., 62, 1939, 188.) Named far Morav, who first inhalted the type species.

Small, short, rod-shaped cells, usually occurring singly or in pairs. Non-motile.

Parasitic. Aerobic. Gram-negative.

The type species is Morazella lacunata (Eyre) Lwaff.

#### Key to the species of genus Moraxella,

I. Na grawth in gelatin.

1. Morazella lacunaia.

II. Gelatin liquefied.

A. Rapid liquefaction. No growth in milk.

2. Morazella liquefaciens.

B. Very slow liquefaction. Cells capsulated. Growth in milk.

3. Morazella bovis.

1. Moraxella lacunata (Eyre) Lwoff (Diplolacille de la conjunctivite subaigue, Morax, Ann. Inst. Past, 10, 1896, 337; Diplobacillus of chronic conjunctivitis, Axenfeld, Cent. I. Bakt., 1 Abt., 21, 1897, I. Bacterium conjunctivitis Chester, Ann. Rept. Del Col. Agr. Exp. Sta., 9, 1897, 83, Bacillus lacunatus Eyre, Jour. Path. and Bact., 6, 1899, 1; not Bacillus

lacunatus Wright, Memoirs Nat. Acad Sci., 7, 1805, 435; Diplobacillus moraracnfeld McNab, Klinische Monatbl. f. Augenheilk., 42, 1901, 64; Bacterium dupter Lehmann and Neumann, Bakt-Diag. 2 Aufl., 2, 1899, 193; Hemophilus Iacunatus Holland, Jour. Bact., 5, 1929, 223; Bacillus dupler Hewlett, Med. Res. Council Syst. of Bact., 2, 1929, 417;

Arranged by Prof. E. G. D. Murray, McGill University, Montreal, P. Q., Canada, September, 1945.

Lwoff, Ann. Inst. Past., 62, 1939, 173; Hemophilus duplex Murray, in Manual, 5th ed., 1939, 308) From Latin, pitted.

Audureau (Ann. Inst. Past., 64, 1940, 128) recognizes an atypical variety of this species. To distinguish between the two varieties, she designates these as Morazella lacunda var typica and Morazella lacunda var. atypica.

Short rods: 04 to 05 by 20 microns, occurring singly and in pairs and short chains. Ends rounded or square in the chains. Non-motile. Gram-negative

Gelatin colonies; No growth

Gelatin stab No growth.

Blood agar colonics: Small, circular, transparent, entire. Growth on aub-culture difficult, Certain strains are not surrounded by zones of hemolysis, others are (Oag, Jour. Path, and Bact, § 44, 1912, 193).

Serum agar colomes Delicate, grayish Loffler's blood serum Slow but definite hquefaction (pitting) around the

colonies
Ascitic broth: Turbid with slight,
grayish rediment.

Blood milk mixture. Doubtful de-

Latmus milk. Unchanged

Potato No growth.

Indole not formed.

Nitrites not produced from nitrates.

Various enrishlydrates and mannitol

are attacked Optimum temperature 37°C.

Aembie, lacultative.

Source I'rom conjunctive

Habitat The cause of subscute infectious conjunctivitis, or angular conjunctivitis

2 Morarella liquefaciem (McNah) comb nor (Diploiacide liquefant, Pettit, Annales d'oculatique, March, 180, 160 and Treus, Paris, 1800, 223, Diplobecillus (application McNah, Klimstele Moratibl f Augerbeilk 45, 1901, 64, Bacillus duplez legisfaciera l'awd, Ann Intel Part (24, 1902), 170; Morarella Intel Part (24, 1902), 170; Morarella duplex liquefaciens Lwoff, ibid., 171; Moraxella duplex Lwoff, ibid., 171; Moraxella duplex var. liquefaciens Audureau, Ann. Inst. Past., 64, 1910, 139.) From Latin, liquefying.

Diplobacille: 1 0 to 1.5 by 2 0 microns, occurring singly and in pairs, and having rounded ends. Capsules not demonstrated. Non-motile Stain uniformly with basic aniline dyes. Grum-negative. Gelatin colonies Round, 1.5 to 20

mni in diameter, yellowish-white. Gelatin stab. Rapid liquefaction.

Blood agar: Ready growth in primary

Ascitic agar colonies: Grayish, thick, round, viscous

round, viscous

Peptone agar colonies: Same as above,

but less abundant growth.

Congulated scrum: Liquelaction in 3

to 4 days, eventually complete.
Plain broth, Poor growth, If any

Slight uniform turbidity.

Ascrite broth. Abundant growth in 21

hours at 35°C. Uniform turbidity. Later sediment and an opique pellicle. Milk. No growth. No congulation.

Potato Slight, yellowish-white, vis-

Optimum temperature between 20° and 37°C. Killed at 55°C for 15 minutes.

Aerolae.

Not pathegenic for laboratory animals. Source: From cases of conjunctivitis associated with corneal ulceration in man.

Hibitat: Conjunctivitis in man so far

3. Morazelia bovis (Haudurey et al.)
comb nor. (Dipholacillus, Allen, Jour
Amer Vet Med Aven, 64, 1918, 2017,
Dipholacillus, Jores and Little, Jour.
Lay Med, 35, 1223, 130, Herochstus
boris Haudurey et al., Diet d. Bier.
Path., 1937, 247, Movozella dupler des
Boxalés, Livell, Arm. Irst. Part., 62,
1979, 134; Herophilus ruminantium
Bept and Adjectin, Texas Reports on

Biol. and Med., 3, 1945, 187.) From Latin boris, of the ox.

Short, plump rods: 0.5 by 1.5 to 20 microns, usually occurring in pairs and short chains, with rounded ends. Capsulated. Non-motile. Gram-negative.

Gelatin: Slow growth at 22°C. Very

slow liquefaction.

Blood agar colonies: After 21 hours, round, translucent, grayish-white, surrounded by a narrow, clear zone of hemolysis. Deep colonies tiny with a clear hemolytic zone, usually 1.5 mm in diamcter. After 48 hours, surface colonies somewhat flattened, 3.5 to 4 mm in diameter; deep colonies ellipsoidal and biconvex with hemolytic area of 2.5 to 3 mm in diameter.

Blood agar slants; After 24 hours at 38°C, heavy, viscid, grayish-wlute growth.

Congulated serum liquefied.

Broth: Slow growth. Slight turbidity. Considerable sediment.

Litmus milk: Alkaline, Partial coagulation.

Indole not produced

Potato: No growth.

No acid from glucose or other carbohydrates

Not pathogenic for laboratory animals. Killed at 55° to 59°C in five minutes.

Aerobie. Source From cases of acute ophthalmia (pink eye) of cattle

Habitat: In the exudate from cases of acute ophthalmia of cattle. The probable cause of bovine infectious keratitis (Baldwin, Amer. Jour. Vet. Res., 6. 1945, 180).

Appendix: Other species placed in the genus Morazcila are as follows:

Morazella josephi Lwoff. (Bacillus duplex josephi Scarlett, Annales d'Oculistique, 153, 1916, 100 and 485; Lwoff, Ann. Inst. Past , 62, 1939, 171; Morazella duplex josephi Lwoff, ibid., 174; Bacillus josephi Audurcau, Ann. Inst. Past., 64. 1940, 126.) Gram-positive. Pathogenic. From the conjunctiva of man.

Morazella lwoffi Audureau, (Ann. Inst. Past., 64, 1940, 150.) Two varieties are recognized: var. bacteroides and var. brevis. From various types of

conjunctivitis in man. Morazella non liquefaciens Lwoff. (Bacterium duplex-nonliquefaciens Oliver and Wherry, Jour. Inf. Dis, £8, 1921, 342; Bacillus duplex non-liquefaciens Hewlett, Med. Res. Council Syst. of Bact , 2, 1929, 418; Lwoff, Ana. Inst. Past., 62, 1939, 171; Morazella duplex non liquefaciens Lwoff, ibid, 174; Bacillus duplex non liquefaciens Audureau, Ann. Inst. Past., 64, 1940, 126; Morazella duplex var. non liquejaciens Audureau, ibid., 144.) From an ulcer of the cornea, and from bronchial aputum in man

# Genus III. Noguchia Olitsky, Syverton and Tyler.\*

(Jour. Exp. Med , 60, 1934, 382.) Named for Noguchi, the bacteriologist who isolated the type species.

Small, slender, Gram-negative rods present in the conjunctive of man and animals affected by a follieular type of disease; mucoid type of growth which on first isolation takes place with some difficulty in ordinary media; motile, flagellated, and encapsulated; aerobic and facultative anacrobic; optimum temperature for growth 28° to

The type species is Noguchia granulosis (Noguchi) Olitsky, Syverion and Tyler.

Key to the species of genus Noguchia.

I. Acid from carbohydrates.

A. Acid from raffinose, maltose and salicin. 1. Noguchia granulosis.

<sup>\*</sup> Arranged by Prof. C. D. Kelly, McGill University, Montreal, October, 1938.

- B. No acid from raffinose, maltose and salicin.
- II. No acid from earbohydrates.

2. Noguchia simiae.

3. Nocuehia euniculi.

 Noguchia granulosis (Noguchi) Olitsky et al. (Bacterium granulosis Noguchi, Jour. Exp. Med. 48, Supp. 2, 1928, 21; Olitsky, Syverton and Tyler, Jour. Exp. Med., 69, 1931, 382.) From Latin, granular.

Roda: 0.25 to 0.3 by 0.8 to 1.3 microna, motile by means of a single flagellum, usually polar. Pleomorphic, Gram-negative.

No growth on plain agar or broth

Blood agar plate. Minute round colonics, shiny, somewhat raised, almost transpirent or slightly grayish in 45 hours Later the colonies increase in size, are grayish patiescent and somewhat sticky. Old colonies have a brownish or yellowish tint.

Semi solid Leptospira medium: Grayish-white, diffuse growth, forming a delicate zone I cm deen.

Liquid Leptospira medium. Diffuse, sightly cloudy growth, with sticky grayish sediment at the bottom of the tule in old cultures.

Acid from flurose, fructore, mannese, suemos, galaciose, maltose, salicin, sylose, mannitol, destrin, arabinose, amygdalin and lactose. Small amount of seul from rationese, inulin, tlamnose and treladore. No acid from dulertol, porbitol and inovitol.

Non-pathogenic for rabbits, guines, pigs, rata and mice.

Optimum pll 7.8.

Temperature relations Optimum 15° to 30°C Grows at 37°C Aerobe, ficultative anaerobe

Distinctive characters. Action on ear-

tibits at 13°, none at 37°C Source From trachoma of American Indians at Albuquerque, New Merican Halitat, Remarket Les Novache and

Habitat, Regarded by Negucia and others as a cause of trackoma in man

Produces a granular conjunctivitis in monkeys and apes

2. Noguchia simiae Olitsky et al

(Bactestum simiae Olitsky, Syverton and Tyler, Jour. Exp. Med., 67, 1933, 875, Olitsky et al., Jour. Exp. Med., 69, 1931, 382). From Latin sumia, spe. Slender rods; 02 in 03 by 0.8 to 12 merons, occurring singly, in pairs, in short chains or parallel arrangement of two or three, having pointed ends. Capsules are found, Actively mutile by means of a single, rarely a foulbe, fagely.

lum, usually polar. Gram-negative

Gelatin plates. Colonies more muched
and raised than on agar.

Gelatin stab: Arachnoid growth along line of inoculation No liquefaction

Agar plates. Small, circular, grayish, translucent, smooth, convex, slightly raised colonies having a sticky or mucoid consistency

Blood agar plates. More highly translucent and coloriess in early growth than on plain agar, becoming grayish after two or three days.

Agar stants. Grayisle-white to white, most, nucoid, raised, glistening grawth. Grawth is more profuse when blood is added.

Leptopira medium: Homegeneous, dense growth in a 0.5 cm sharply defined byer, with a elight, nebulous, uniform openity about 1 cm below. In three or four days the loner layer becomes more dense and in time extends to the bottom of the tube.

Broth Uniform turbidity, with a slight grayish redinient and no pellicle.

Litmus rdk Urcharged

Potato Taglit tan, spreading, abundant grouth

Indde tot force! Nitrites tot produced form intestes Acid but no gas form gluesce, fruction. mannose, galactose, xylose, arabinose and rhamnose. Small amount of acid from dextrin. Some strains produce a small amount of acid from sucrose, lactose, inulin and mannitol. Raffinose. salicin, dulcitol, amygdalin, maltose, trehalose, sorbitol and inositol unchanged.

Serological reactions: Rabbit antiscrum is specific for all strains and no cross agglutination with Naguchia granulosis.

Temperature relations: Optimum 28° to 30°C. Thermal death point 56°C for thirty minutes.

Aerobe, facultative asserobe,

Distinctive characters: Action on carbolydrates; agglutination reactions.

Source: From inflammatory type (Type II) of spontaneous conjunctival folliculosis in Macacus rhesus monkeys.

Habitat: Causes conjunctival folliculosis in Macacus rhesus monkeys.

3. Noguchia cuniculi Ohtsky, Syverton and Tyler. (Jour. Exp. Med., 60, 1934, 382 ) From Latin cuntculus, rabbit.

Slender rods, 0 2 to 0.3 by 0.5 to 10 micron with pointed ends. Capsules are formed of much finer texture than thoso surrounding Noguehia granulosis or Noguchia simiae. Actively motile with peritrichous flagella. Non-acid-Pleomorphic forms sometimes noted. Gram-negative\*

Gelatin agar plates Grayish, mucoid and confluent colonies

Gelatin stab. Tenuous, arborescent, non-spreading growth No liquefaction Agar plates Small, spherical, translu-

cent, slightly grayish, smooth, somewhat convex, moist and mucoid colonies with entire edges

Blood agar plates. More profuse, more grayish and less translucent than on plain

agar.

Agar slaats: Slightly grayish, translucent, conlescent, glistening, mucoid, homogeneous and non-spreading growth, The water of syneresis appears uniformly cloudy or milky depending on amount of growth.

Leptospira medium: After 24 hours, a faiat, nebulous surface growth followed by an ingrowing sac like mass, with its base 5 mm across, lying at the center of the under surface and extending for 5 mm into the medium. The area spreads laterally until at about two or three days there is a uniform, opaque, whitish layer about 1 cm thick which progresses slowly until the bottom of the tube is reached in about seven days.

Broth: Uniform turbidity, without

pellicle.

Litmus milk: Unchaaged.

Potato: Faint, buff-colored (changing to brown after five days), non-spreading, sparse surface growth.

Indole not produced.

Nitrites not produced from nitrates. No acid or cas from clucose, fructose, mannose, mannitol, sucrose, raffinose, mulin, galactose, maltose, salicin, xylose, dextrin, arabinose, amygdalia, lactose, dulcitol, rhamnose, trehalose, sorbitol or inositol.

Serological relations: Rabbit satisfrum is specific for all strains, and no cross agglutination with Noguchia granulosis or Noguchia simiae.

Temperature relations: Optimum 28° to 30°G. Thermal death point 56°C for 15 to 30 minutes.

Acrobe, facultative anserobe. Distinctive characters: No action on

carbohydrates; peritrichous flagella; agchitmation. Source: From spontaneous conjunctival

folliculosis. Type II of rabbits.

Habitat: Causes conjunctival follieulosis in rabbits.

Genus IV. Dislister Bergey et al.\*

(Manual, 1st ed , 1923, 271.)

Minute rod-shaped cells, occurring singly, in pairs and short chains. Non-motile.

<sup>\*</sup> Rearranged by Prof. D. H. Bergey, Philadelphia, Peansylvania, 1933.

Strict parasites. Growth occurs only under amerobic conditions in media containing fresh, aterile tissue or ascitic fluid.

The type species is Diglister pneumosintes (Olitsky and Gates) Bergev et al.

1. Dialister pneumosintes (Olitaly and Gatea) Bergey et al. (Bacterium pneumosintes Olitaky and Gatea, Jour Evp. Med., 35, 1921, 713; 1bid., 35, 1922, 813; Bergey et al., Manual, 1st ed., 1923, 211; Bacillus pneumosintes Ford, Texth. of Bact., 1927, 631.) From Greek pneumon, lung and sintor, murderer or devastator.

Very short rods: 0.15 to 0 3 (in glucose broth 0.5 to 1.0) micron in length, occurring eingly and occasionally in pairs, short chains or masses. The ends are rather pointed. Non-motile. Gramnecative.

Blood agar colonies. Small, clear, circular, entire, translucent.

Growth occurs in media containing fresh sterile rabbit kidney and acctue fluid. Under atrict anaerobic conditions good growth on rabbit blood glucose agar plates.

Glucose broth in which Escherichia coli or Bacillus mescniericus (non-spore stage) liss grown favors growth

Acid but no gas from glucose Neither acid nor gas from maltose, lactose, sucrose, inclin or mannitol.

Passes Berkefeld V and N filters Optimum pH 7A to 7S. No growth

at pli 70 or pli 80.

Optimum temperature 37°C. Does

not survive 56°C for half an hour. Pathogenic for rabbits and guinea pigs

Strict anaerobe Source From filtered nasopharyageaf

secretions from influenza patients in the early hours of the disease.

Habitat: Nasopharyngeal washings of man

 Dialister granuliformans (Pavlovic) Bergey et al. (Bacteruum granuliformans Pavlovic, Cent f. Bakt, I. Abt., Orig., 112, 1929, 132; Bergey et al., Manual, 4th ed., 1931, 341.) From Latin, forming granules.

Small rods, Non-motile, Gram-nega-

tive.

Agar colonies: Very small, transparent. No gas.

Broth: Turbid.

Litmus milk: Unchanged.

Indole not formed.

Acid from glucose, sucrose and man-

nitol

Passes through Chamberland In filters.
Pathogenic for rabbits.

Optimum temperature 37°C.

Anaerobic to microserophilie.

Source. From respiratory tract in influenza

Habitat: Mucous membrane of respiratory tract.

Appendix, Family Parvohacteriaceae:\* De Bord (Iona State Coll. Jour. Sci., 16, 1942, 471) describes a new tribe. Mamene, which may belong in this family The tribe includes three genera; Mema with the species Mima polymorpha and the variety Mima polymorpha var. oxidans: Herellea with the single species Herellea raginicola; and Colloides with the single spream Collowles anoxydana. The organisms are Gram positive, pleamorphic, motile or non motile rads, often showing birolar staining, and were isolated from the normal vagina and from cases of vaginitis and conjunctivities Deacon (Jour. Bact , 49, 1945, 511) classifice nineteen cultures in these genera.

<sup>\*</sup> Arranged by Dr. A. Parker Hitchens, University of Pennsylvania, Ph.ladelphia, Pa., March, 1946

# FAMILY XII. BACTERIACEAE COHN.\*

(Arch. f. path. Anat. u. Physiol., 55, 1872, 237.)

Rod-shaped cells without endospores. Motile or non-motile. Gram-positive and Gram-negative. Metabolism complex, amino acids being utilized, and generally carbohydrates.

This is a heterogeneous collection of species whose relationships to each other and to other groups are not clear.

Only a single genus is recognized at this time.

# Genus I. Bacterium Ehrenberg.

(IV. Evertebrata, Berlin, 1828, 8.) The original description of this genus follows:

Bacterium, Novum Genus, Familia Vibrionorum Character Generis. Corpus polygastricum? anenterum? nudum, oblongum, fuesforme aut filiforme, rectum, monomorphum (contractions nunquam dilatetum), parum flevile (nec aperte undatum), transverse in multas partes spente dividuum.

This may be translated as follows:

Bacterium, new genus | Family of Vibriona | Character of the genus; Body with many atomachs? without an intestine? naked, oblong, apindle-shaped or fillorm, straight, monomorphic (in contraction never dulated), not very plant (and not definitely wavy), freely separated transversely into many paris

The type species is Bacterium triloculare Ehrenberg.

The original description of this species follows:

B. trileculare nov. spec., distincte triloculare a trarticulatum, subjustiormum, hyalinum. Animalculum 1/200 lineae longum, corpore terets. Articulas septa interna divisionam instantem multi-

Los replero hae formae respunt

ideoque ad Polygastrica non misi dubitanter et interim conocana.

This may be translated as follows:

B. triloculare new spec Definitely with three compartments or three jointed, subfuniorm, by since Animalcules 1/300 of a line in length, with a smooth body. The jointe or internal septa are observed to develop preliminary to multiple transverse splitting. A motile but sluggish animalcule. Observed in the - --- at Con a nowhere else.

re. These forms refuse to fill their stomachs with acy and only temporarily in the Polygastrica.

The original descriptions are taken from Buchanan, General Systematic Bacteriology, 1925, 213, and the translations are also furnished by him. Buchanan in his book gives an excellent summary of the numenclatural status of the term Bacterium ~~ ~~ ~~ 913~930

. . . . . . . . a way to permit ies of non-spore-

.ssification is not

forming, rod-shaped bacteria whose position ... definitely established (Breed and Conn, Jour. Bact , 51, 1936, 517).

Completely rearranged by Prof. Robert S. Breed and Mrs. Eleanore Heist Clise. New York State Experiment Station, Geneva, New York, May 1946.

Bacterium triloculare Ehrenberg, (Ehrenberg, IV. Evertebrata, Berlin, 1828, Sc.; Bacıllus chrenbergni Trevisan, I generi e le specie delle Batteriacec, 1899, 18; Bacterium chrenbergni De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1922; Bacterium lineola Cohn, Beiträge z. Biol. d. Pflanten, f. Heft 2, 1872, 1703. Cohn also regards Vetrio lineola (Bieler, 1855 and Vibrio lineola (Bacillus lineola, Bactrium lineola) of other authors as synonyms of Bacterium triloculare as explained by Buchanan (loc. cit, 213 and 521). From Latin Iri, three and loculus, cells or compartments.

Key to the remaining species of genus Bacterium.

#### I. Gram-positive.

- A. Non-motile.
  - 1. Nitrites produced from nitrates.
    - 1. Bacterium erythrogenes,
    - 2. Bacterium zubrufum.
    - 3 Bacterium linens.
    - 4. Bacterium mycoides.
      5. Bacterium mutabile.
    - 6. Bacterium mutabile.
  - 2. Nitrites not produced from nitrates.
    - a, Grow on ordinary media
      - 7 Bacterium racemosum
      - 8 Bacterium healis.
      - 9 Bacterium insectiphilium
      - 10. Bacterium tegumenticola
      - 11 Bacterium minutoferula 12. Bacterium fulcum.
    - as Grow only on sea water media on fresh isolation.
      - 13 Bacterium marinopiscosus
        - 11 Bacterium sociorirum
        - 15 Bacterium immatum
  - 3. Action on nitrates unknown.
    - 16. Bacterium ammontagenes
      - 17. Bactersum manutistimum
  - Motile in young cultures
     Nitrites not produced from nitrates
    - 18 Backerium incertum
    - 19 Bacterium imperiale
- C Motile Protens-like growth on media
  - 1 Nitrites not produced from nitrates
    - 20 Bacterium zopfit
    - 21 Bacterium zenkeri

Appendixes I and 11: These list 31 additional species of Gram positive, motile or non-motile, non-spore forming, red-shaped bacteris. See p. 600 and 612

- 11 Gram negative Digest cellulose. Do not digest ager
  - A Non-motile Gelatin liquefied Chromogenie 1 Milk seid
    - 22. Bactersum idoneum.
    - 22s. Bacterium liqualum

- B. Non-motile. Gelatin liquefied. Non-chromogenic.
- 1. Milk acid.
  - Ammonia produced; indole not formed.
     Bacterium udum.
- C. Non-motile. Gelatin not liquefied. Non-chromogenic. 1. Milk unchanged.
  - a. Ammonia not produced; indole not formed,
    21. Bactersum lucrosum.
  - 2. Milk seid.
    - a. Ammonia not produced; indole not formed.
      - 25. Baclerium acidulum.
- 26. Bacterium castigatum.
  D. Motile. Gelatin liquefied. Chromogenic.
- 1. Milk acid.
  - a. Ammonia produced; indole is formed.

    27. Bacterium bibulum.

Appendices I to III: These list additional species of cellulose-digesting, Gram-negative, usually motile, rod-shaped bacteria. See p. 615 and 622. Also similar species that utilize bacterial polysaccharides as a sole source of carbon. See p. 623.

## III. Gram-negative. Digest agar.

- A. Non-motile.
  - Nitrites not produced from nitrates.
    - a. Acid from glucose and other sugars
      28. Bacterium nenckii.
      - 25. Bacterium nenckii
    - as. Do not form seid from glucose.
    - Bacterium polysiphoniae.
       Bacterium drobachense.
  - 2. Action on nitrates unknown.
    a. Do not form acid from glucose.
    - 31. Bactersum delesseriac.
    - 32. Bacterium boreale.
    - 33. Bacterium ceramicola.
- B Motile but position of flagella not given. May be either peritrichous or
  - I. Nitrites not produced from nitrates
  - 31. Bacterium rhodomelae.
  - Action on nitrates unknown.
    - 35 Baelersum alginovorum.
    - Bacterium fucicola.

dia See p. 627.

- IV. Gram-negative. Digest chitin.
  - A Motile but position of flagella not given.
    - 1. Non-chromogenic.
- 27. Bacterium chitinophilum.
- Yellow chromogenesis.
- 38. Bacterium chitinochroma.

Appendix I: One additional species is described. See p. 632.

- V. Gram-negative. Phosphorescent bacteria.
  - A. Non-motile eoceobacılli from sea water. 1. No liquefaction of relatin.

39. Bacterium phosphoreum.

B Motile rods from sea water Position of flagella not given. 1. No growth in broth, and on coagulated blood serum or potato.

40. Bacterium phosphorescens indigenus.

C Not stated whether motile or non-motile From diseased insect larvae.

1 Yellow growth on potato

41. Bacterium hemophosphoreum.

Appendix I: The includes a list of more than 40 additional so-called species of phosphorescent bacteria See p 631.

- VI. Gram-negative. Facultative autotrophic bacteria which secure energy from the oxidation of hydrogen and utilize earbon from COs.
  - A Non-motile.
    - 1. Growth shows a red chromogenesis.
    - 42 Bacterium eruthrooloeum.
    - B. Motile with peritrichous flagella. 1. Yellow chromogenesis.
      - 2. Ivory-colored colonies
- 43 Bacterium lentulum. 41 Bactersum leucogloeum,
- VII Gram-negative. Plant pathogens
  - A Non-motile
    - I Gelatin not hquefied 45 Racleeum stewartu.
  - 13 Motilo with a polar flagellum
    - 1. Gelatin not hourfied
      - a. Colonies mustard yellow on ager.
      - 4G Haelersum tardierescens.
      - b Colonies honey to Naples yellow on ager. 47 Bactersum albilineans

Appendix I: This includes 19 additional species placed in Bacterium or Bacil. lus by their authors. All are reported to cause or to be associated with plant disease See p 639

- VIII Gram negative. Miscellaneous species
  - A Produce a pink to red chromogenesis
    - 1 Motile a Gelatin not liquefied

      - 45 Bactersum rubefaciens as Gelatin liquefied
    - 2 Non motile
      - a Celatin not housefied
- 19 Hacterium rubidum 50 Hacterium latericeum.

- B. Do not produce pink or red chromogenesis.
  - 1. Motile.
    - a. Produce clouding in alginic acid liquid medium.

b From sea water.

51. Bacterium alginicum.

bb. From soil.

- 52. Bacterium terrestralginicum.
- sa. Action on alginic acid unknown.
  - b. Causes a disease of swans.
- 2. Non-motile.
  - a. Causes red spot disease of carp.
    - 54. Bacterium cyprinicida.
  - an. Causes liberation of ammonia from a mixture of horse manure and urine.

53. Bacterium eveni.

- 55. Bacterium parvulum.
- ana. Utilizes formates in a liquid medium with the formation of a reddish pellicle.

56. Bacterium methylicum.

Appendix I: Miscellaneous described species of non-spore-forming bacteris placed by their authors in the genus Bocillus. See p. 643.

Appendix III: Includes an aerobic bacteria that produce methane. See p. 615
Appendix III: Miscellaneous species of non-spore-forming bacteria listed
but not described. See p. 647.

1. Bacterium erytbrogenes Lehmann and Neumann. (Bacterium lactis erythrogenes Grotenfelt, Fortschr. d. Med., 7, 1889, 41: Bacillus lactis eruthrogenes Sternberg, Manual of Bact., 1893, 636; Lehmann and Neumann, Bakt, Diag., 1 Aufl., 2, 1896, 253; Bacillus erythrogenes Matzuschita, Bakt. Diagnostik, 1902, 220; Corynebacterium erythrogenes Kisskalt and Berend, Cent. f. Bakt., I Abt, Orig., 81, 1918, 446; Erythrobacillus erythrogenes Holland, Jour. Bact., 6. 1920, 218; Erythrobacillus (lacits) erythrogenes Holland, ibid; Serratia lactica Bergey et al., Manual, 1st ed., 1923, 93; Chromobacterium lacits erythrogenes Topley and Wilson, Princip Bact. and Immun., 1, 1931, 402 ) From Greek, redproducing.

Micrococcus lactis crythrogenes Conn, Esten and Stocking, Ann. Rept. Storrs (Conn.) Agr. Exp Sta., 18, 1906, 117 is stated to be allied to if not identical with the above species.

Reds: 0.3 to 0 5 by 1 0 to 1 4 microns, in broth often up to 4.3 microns long,

occurring singly, and having rounded ends. Non-motile, Stain with the usual aniline dyes. Gram-positive (Lehmann and Neumann, toc. ctt.).

Gelatin colonies: Small, circular, grayish, becoming yellow, sinking into the medium. Crateriform hquefaction. Yellow sediment. Medium becomes rose-colored.

- + first an manual a whitish.

surince, the name because yellow sediment. The solid portion assumes a weak rose color.

Agar stab: Moist, fairly luxuriant, yellow growth, the medium assuming a rose to wine color.

Broth: Turbid, yellow. Pellicle (Fuller and Johnson, Jour. Exp. Med., 4, 1899, 600).

 tral or alkaline A stratum of blood-red scrum is seen above the precipitated casein and above this a yellowish-white layer of cream. An intensive sweet odor that becomes disacrecable.

Potato: Growth repid, spreading, graysh, later yellow. On incubation a deep golden yellow color develops after 6 to 8 days. A darkening of the medium occurs around the culture, but soon disappears; later the whole potato becomes a weak yellowish red.

Indole not formed (Fuller and Johnson, loc ett.). Indole formed (Chester,

Manual Determ. Baet., 1501, 174).
Blood serum: Liquefied (Fuller and Johnson, loc. cit.). Not liquefied (Heff-

eran, Cent. f. Bakt., 11 Abt., 11, 1903, 456). Nitrites produced from nitrates

No gra from earbohy drates.

Slight II,S production (Matzuschita, loc cit.). Red pigment insoluble in water, alco-

hol, ether, chloroform, and benzol. Soluble (Helleran, los cit., 529). Yellow pigment insoluble.

Distinctive character: Milk becomes blood-red in 12 to 20 days.

blookl-red in 12 to 20 days.

Non-pathogenic for raice (Fuller and

Johnson, loc. ett.).
Optiraum temperature 28° to 35°C
Arcobie (Puller and Johnson, loc. ett.).
Facultative anacrobe (Hefferan, loc.

cit , 530).

Source: Isolated from red milk by Hueppe in Wieshaden in 1884. Isolated from feece of a child by Beginsky (Cent. F. 1844. 6, 1889, 137). Isolated from feece with the second from the second from Missis uppi liver water by Helferan (loc. of 1). Isolated from Missis uppi liver water by Helferan (loc. of 1). Tatarolf isolated a rose fluorescent cocchecterium (Bacillus renoffuencema Kruse, in Fluore, Die Mikrongsniemen, 3 and 2, 1895, 393; Roderium rose fluorescens Clester, Ann. Rept. Del Col Art. Epp. Sta. 2, 1875, 1129 which Migula reports as identical, but which Heferan conditions at which

Habitat: Probably widely distributed in nature.

 Bacterlum subrulum Burri and Staub. (Burri and Staub, Landwirtsch.
 Jahrb. d. Schweiz, 40, 1926, 1006; Serratia subrufa Bergey et al., Manual, 3rd ed., 1930, 123.) From Latin sub, somewhat and rulus, red.

This organism is stated to be closely related to or possibly identical with Bacterium crythrogenes.

3. Baeterlum Ilmens Weigmann. (Organismus 1-X, Wolff, Milchwitt. Zont., 8, 1909, 145, Weigmann, in Wolff, Cent. 6 Bakt., 11 Abt., 28, 1910, 422, and in Weigmann, Mykologie der Milch, 62, 1911, 220.) From Latin, daubing, smearine, or spreadung over.

Also see Steinfatt, Milchwirt. Forsch., 9, 1930, 7; Kelly, Jour. Dairy Sci., 20, 1937, 239; Albert, Long and Hammer, Iowa Agr. Exp. Sta. Res. Bul.

328, 1914.

Rods: Average 062 by 2.5 microns when grown I to 2 days on tryptone glucose extract agar. Non-motile (Wolf), Gram-positive (Kelly, loc. cel.).

Gelatin colonies: At 18°C punctiform at first; after 12 days about 1 ram in diameter, compact, circular, alony, brownish-yellow to real-brown Lique-

faction.

Gelatin stah: At 21°C crateriform figurfaction, becoming infundbul/aform on extended incubation. Rate of liquefaction varies considerably with different cultures, some completing it in 15 days, others not completing it even on long invulvation.

Agar colonies: On tryptone glucose extract agar at 21°C after 1 to 2 days, colonies convex, glustening, entire and cram-colored, Jeconing brown on extended incubation; dismeters 2 to 5 mm. On special clarese agar with inculation in oxygen, lavuriant growth, the color laceming bright crange to reddshivona in 4 or 5 days.

Agar stab: Heavy surface growth on tryptone glucose extract agar at 21°C with no growth along the line of inoculation.

Agar slant: On tryptone glucose extract agar at 21°C after 2 days growth abundant, glistening, filiform, non-viscid and cream-colored. After extended incubation the color usually is brown. On special cheese agar in an atmosphere of oxygen the growth is bright orange to reddish-brown in 4 or 5 days.

Broth: Turbidity and sediment. Potato. At 21°C after 5 days, growth is

scanty, smooth, glistening, and varies in color from grayish to brownish-orange.

Litmus milk. At 21°C the changes are very slow. After 6 or 7 days the reaction becomes alkaline and a yellow sediment appears. After approximately 10 days some digestion is evident, complete digestion generally requiring several weeks to over a month. A distinct ammoniacal oder, more or less objectionable, produced in old cultures No coagulation. Ropiness often produced on extended incubation.

Indole not produced.

Nitrites produced from nitrates

Methyl red and Voges Proskauer reactions negative.

Hydrogen sulfide produced in broth and on agar by some cultures but not by others.

Natural fats not hydrolyzed

No acid or gas from arabinose, devtrin, glucose, dulcitol, galactose, inulin, lactose, fructose, maltose, mannitol, raffinose, rhamnose, salicin, sorbitol, sucrose or xylose.

Ethyl, propyl, butyl and amyl alcohols oxidized largely to corresponding acids; hexyl and heptyl alcohols attacked much less actively

Catalase rapidly produced in or on various media.

Aerobic.

Growth temperatures. Growth at 8° and 37°C but not at 45°C, with the optimum at about 21°C.

Heat resistance low, cultures being killed at 62.8°C in a few minutes.

Growth in the pH range 6 0 to 9.8; no growth at pH 5.0 or below.

Salt tolerant, cultures growing readily in a concentration of 15 per cent salt in broth or skim milk, with certain cultures apparently capable of growing somewhat in much higher concentrations.

Closely related to or identical with Bacterium erythrogenes Lehmann and

Neumann

Source: Originally isolated by Wolff from the surface flora of various soft cheeses,

Habitat: Widely distributed in and especially on the surface of dairy products including blur, brick, camembert, limburger, oka and cheddar cheeses, butter, milk and cream. Also found in various feeds including grains, slage, green plants, hay and straw, and in water, soil, nanure, and air.

4. Bacterlum mycoides (Grotenfelt) Migula. (Bacterlum mycoides rosum Grotenfelt, Fortschr. d. Med., 7, 1889, 46; Bacullus mycoides roseus Sternberg, Manual of Bact., 2, 1900, 482; Bacullus mycoides-roseus Holland, Jour. Bact., 6, 1920, 219; Erythrobacullus mycoidesroseus Holland, bbd.; Serratia rosea Bergey et al., Manual, 1st ed., 1923, 90; Chromobacterium mycoides roseum Popley and Wilson, Princip. of Bact. and Immun. 1, 1931, 402.) From Greek mytes, fungus and eudos, form.

Rods: Non-motile. Gram-positive. Gelatin colonies: Red, felt-like.

Liquefaction

Gelatin stab: Rapid liquefaction. Red pellicle. Red sediment.

Colonies composed of interlacing filaments (Crookshank, Textb of Bact, and Inf Dis , 1900, 524).

Agar stab: Red color produced if grown in dark; a white color in presence of light. Optimum temperature: Room temperature.

Pigment soluble in water.

Distinctive charactera. Morphologacally like the anthrax bacillus. Appearance in gelatin Production of a brilliant rose color when grown in the dark; colonics grown in the hight are white, but they assume the red color if developed further in the dark.

Source · Isolated from Wiesbaden soil by Scholl

Habitat : Unknown.

Note. It has been claimed that this or a similar organism forms spores (Matzuchtia, Baet Diag., 1902, 163). Perlberger, Cent f. Bakt, H. Abt, & 1921, 8). However cultures of Scholl's organism received from the Kral collection by Hefferon (Cent f. Bakt, H. Abt, H. 100, 459) and by Breed in 1926 (personal communication) did not form spores. These cultures produced nitrates from nitrates and failed to liquefy gelatin

5 Bacterium mutabile Steinhaus (Jour Bact., 42, 1911, 775) From Latin mutabilis, changeable

Short rods On agar, 0.7 to 0.9 by 1.0 to 2.0 microns. In fluid media, such as tryptophrue broth, pleomorphic, bizare forms frequently appearing slightly branched Non-motile. Gram positive

Gelatin stab. Very slow liquefaction. Agar colonies: Cream to yellow, eigcular, smooth, glistening, opaque.

Broth Moderate turbidity, slight sechment

Litmus milk Alksline, soft curd, slowpeptonization

Indole not produced

Hydrogen sulfide not produced Nitrites produced from nitrates Starch not by drolyzed

tilucose, lactose, sucress and maltuse not fermented

Acrobic

Source From the alimentary tract of

the Iyreman cicada, Tibicen linnei. Smith and Grossbeck.

Habitat: Unknown

6 Bacterium qualis Steinhaus. (Jour. Bact., 42, 1941, 774.) From Latin qualis, of what kind.

Short rods. Very short on solid media, frequently ellipsoidal in shape. In fluid media, 0.5 to 0.7 by 1.4 to 2.2 microns, occurring singly. Non-motile. Gram-nostive

Gelatin stab, Liquefaction.

Agar colonies: Small (1 mm), white, glistening, transparent, circular, entire.
Agar slant. Filiform, smooth, glistening.

Broth: Almost clear; slight turbidity in serum and glucose broth.

Litmus milk, No change. Indole not produced

Indole not produced Hydrogen sulfide not produced.

Slight production of nitrates from ni-

Starch not hydrolyzed

Acid from glucose, sucrose and maltose. Lactore not fermented.

Source From the alimentary tract of the turnished plant bug, Lygus profes-

Habitat Unknown

7 Bacterium racemosum Kettnon (Zettnon, Cent f Bakt, 1 Abt, Orig, 77, 1915, 200, Zettnovia racemosa Enderlein, Bakt Cyclogenie, Berlin, 1925, 250; Flacobacterium racemosum Hergey et al., Manual, 1st ed., 1923, 115.) From Latin racemosus, branching

Filaments 0.5 to 0.5 by 10 to 12 microns Branching forms found Nonmotile Gram positive

Gelatin colonies. White, circular, soft, granular, brownish, entire.

Gelatin stale White surface growth.

Agar elant Light yellow, limited growth

Broth: Turbid

Litmus milk: Coagulated, becoming alkaline.

Potato: Dirty-yellowish, limited streak.

Indole not formed.

Nitrites not produced from nitrates. Aerobic, facultative.

Optimum temperature 20°C.

This species is selected as the type species for the genus Zettnowia Enderlein (loc. cit.).

Source: Contamination on agar plate. Habitat: Unknown.

8. Bacterium healil Buchanan and Hammer, (Buchanan and Hammer, Iowa Agr. Exp. Sta. Research Bull. 22. 1915, 249; Escherichia healii Bergey et al., Manual, 1st ed., 1923, 200; Achromobacter healts Bergey et al., Manual. 2nd ed., 1925, 157.)

Rods: 0.5 to 0 7 by 2.2 to 12.9 microns. occurring singly and in short chains. Non-motile. Gram-positive.

Gelatin stab: Stratiform liquefaction.

Villous growth in stab. Agar colonies: Large, white, rhizoid.

Agar slant: White, hard growth, with no tendency to stringiness.

Broth: Gray pellicle and sediment. Litmus milk Slightly acid, becoming

slimy, coagulated, peptonized. Potato: Heavy, white, glistening growth.

Indole not formed

Nitrites not produced from nitrates. Acid without gas from glucose, fructose, maltose, sucrose, saliein and starch. No acid from mannitol, lactose, raffinese or inulin

Aerobic, facultative Optimum temperature 22°C Source: Slimy milk. Habitat : Unknown

9. Bacterium insectiphilium Steinhaus. (Jour. Bact., 42, 1941, 777.) From M. L. insect, insect and Greek philos, loving.

Rods. 0.8 to 1.2 by 1.0 to 2.8 microns, occurring singly At times appearing almost as cocci or coccobacilli. Nonmotile. Gram-positive.

· Gelatin stab: Liquefaction.

Agar colonies; Light greenish yellow, entire, raised, glistening, circular. smooth, opaque.

Agar slant: Filiform, raised, smooth, glistcoing, opaque growth.

Broth: Moderate turbidity, slight viscid sediment.

Litmus milk: Alkaline, peptonization, and slow reduction.

Potato: Greenish-yellow, thick, moist growth.

Indole not produced.

Nitrites not produced from nitrates. Hydrogen sulfide not produced.

Starch slightly hydrolyzed, No action on the following carbohy-

drates: Glucose, lactose, sucrose, maltose, fructose, mannitol, galactose, arabinose, xylose, dextrin, salicin, rhamnose, raffinose, trehalose, sorbitol, Inulia, dulcitol, glycerol, adonitol, mannose.

Aerobic.

Source: From the body wall of the bagworm, Thursdopteryx ephemeraeformis Haw.

Habitat: Unknown.

10. Bacterlum tegumenticola Steinhaus. (Jour. Baet., 42, 1941, 775.) From Latin tegumentum, cover, skin and cola, dweller.

Small rods: 0.5 to 0 8 by 1.0 to 1.5 microns. Have a tendency to be ellipsoidal on solid media. Non-motile. Grampositive.

Gelatin stab: Generally no liquefaction Variable.

Agar colonies: Tiny (1 mm), white, convex, glistening, circular, entire

Agar slant: Filiform, glistening, grayish white growth.

Broth: Slight turbidity; sediment.

Litmus milk: No change. Indole not produced

Hydrogen sulfide not produced. Nitrites not produced from nitrates.

Starch not hydrolyzed

Acid slowly produced from glucose

and maltose. Acid from sucrose Lactose not fermented.

Source: From the integument of the bed-bug, Cimex lectularius I.

Habitat: Unknown.

11. Batterium minutaferula Steinhaus. (Jour Bact., 42, 1911, 778.) From Latin, small rod.

Very small rods: 0.4 to 0 9 by 0 7 to 1 0 micron, occurring singly Non-motile Gram positive.

Gelatin stab: No liquefaction.

Agar colonies: Colorless to faint gray, eircular, smooth, entire, glistening

Agar slant. Very thin, transparent, glistening growth.

Broth, Slight turbidity and seemment latmus milk. No change at first; slightly need after one week

Indole not produced.

Hydrogen sulfide not produced Nitrites not produced from nitrates

Stareli not hydrolyzed.

Acid from glucose after 4 days. Slight acid from sucrose. Lactose and maltose not fermented.

Acrobic

Source: From triturated specimen of the mud daulier wasp, Secliphron comentarium Dru.

Habitat, Unknown.

12 Bacterlum fulrum (Zummermann). Checter (Biellus falleus Zummermann, Bakt unserer Trink: u Nutrakhere, Chemutt, I, 1830, 41, Chetter, ann. Rept Del Col. Agr. Exp Sta. 9, 187, 197, Firrobneterum fulcum Bergey et al. (Manud.), 18 t. cl., 1923, 1161 From Lattin fulcus, dull yellow.

Rost 0 81, 09 to 13 merons, occur-

ring singly, in pairs and in chains. Nonmottle. Gram positive. Gelain colories. Circular, conses-

Gelatin colories Circular, consex,

Gelatin stab: Convey, re Hish-yellow surface growth. Good growth in stabstor hypefaction.

Agar slant Orange rel, glistening

Broth: Turbid with yellow sediment. Litmus lactose broth: Acid, or acid then alkaline (Dyar, Ann. N. Y. Acad. Sci., 8, 1835, 268).

Potato: Slowly spreading, yellowish, glistening growth.

Indole formed (Dyar, loc. cit.).

Nitrites not produced from nitrates (Bergey).

Acrobic, facultative,

Optimum temperature 30°C.

Source: From Chemnitz and Dobein tap water (Zimmermann) From dust and water (Dyar).

Habstat Water.

13 Bacterium marinopiscosus ZoBell and Upham. (Bull Scripps lint Oceanography, La Jolla, δ, 1911, 253.) From Latin marinus, pertaining to the sea, and piscosus, fish. \*

Rods 12 to 16 by 20 to 4.7 inferons, with rounded ends, show granular staining, occurring singly, in purs and long chains. Non-motile. Gram-positive, but many cells tend to decolorize leaving Gram positive granules.

All differential media except the freshnater broth, litmus milk, and potato acre prepared with sea water.

Gelatin colonies: Gray, circular, convex, I mm. No pigment

Gelatin stah: Laquefaction napiform, becoming erateriform to stratiform with age. Complete in 50 days.

Agar colonies 2 to 4 mm, circular, conrex, entire, smooth, irregular relge.

Agar stant: Larrament, be ided, glistening, butyrous growth with no pigment Serwater broth. No turbidity, alondent floculent sediment, slight surface ring.

Fresh-water broth: Good growth

latmin in Ik. Decolorized, neutral, top peptonized.

Petato Heavy, white, russ I, muroid, diff granth - Potato darkene I. fall-le not forme i.

Natistee not produced from intestes, Ari Heat no gas from glucose and mannitol. No acid from maltose, lactose, sucrose, glycerol, xylose or salicin.

Starch is hydrolyzed.

Hydrogen sulfide not formed.

Ammonia produced from peptone but not from urea.

Cascin is digested.

Fats are not hydrolyzed.

Aerobic, facultative.

Optimum temperature 20° to 25°C. Source: Found on the skin of marine fish.

Habitat: Not known from other sources.

14. Bacterium sociovivum ZoBell and Upham. (Bull. Scripps Inst. Oceanography, La Jolla, 6, 1944, 269.) From Latin socius, associate and vicum, to live.

Rods. 0.5 to 0.8 by 3.0 to 4.0 mierons, with rounded ends, occurring singly, in pairs, and chains. Non-motile. Grampositivo but tends to destain, leaving Gram-positivo cell wall and granules.

All differential media except the freshwater broth, litmus milk and potato were prepared with sea water.

Gelatin colonics: Irregular, sunken, filamentous margin, grayish-white. Gelatin stab Crateriform liquefaction

becoming stratiform.

Agar colomes, 2 to 4 mm, circular,

convex, smooth, entire, darker center.

Agar slant: Luxuriant, beaded, glistening, butyrous growth with no pigment.

Sea-water broth. No pellicle, no turbidity, heavy flocculent sediment

Fresh-water broth Fair growth. Litmus milk Decolorized, neutral,

completely peptonized in 20 days.

Potato Abundant, dull, light cream-

colored growth. Potato darkened.

Indole not formed

Nitrites not produced from nitrates. Acid but no gas from glucose, maltose, and mannitol. No acid from glycerol, lactose, sucrose, or salicin.

Starch is hydrolyzen

Hydrogen sulfide not formed

Ammonia produced from peptone but not from urea.

Casein is digested. Fats not hydrolyzed.

Fats not hydrolyzed Aerobic, facultative.

Optimum temperature 20° to 25°C. Source: Found associated with sedentary organisms in the sea.

Habitat: Commonly found on submerged surfaces and on sessile diatoms in sea water.

15. Bacterium immotum ZoBell and Upham. (Bull. Scripps Inst. Oceanography, 5, 1944, 271.) From Latin, meaning immobile or stationary.

Rods: 08 by 3.1 to 8.6 microns, with rounded ends, occurring singly, in pairs, and long chains. Non-motile. Grampositive but tend to destain leaving Gram-positive outline and granules.

All differential media except the freshwater broth, litmus milk, and potato were prepared with sea water.

Gelatin colonies: Small, circular, raised, gray, slowly digest gelatin.

Gelatin stab: Crateriform liquelaction becoming infundibuliform. Beaded growth along line of stab. No pigment Agar colonies: 1 to 2 mm, circular, convev, smooth, lobate margin, darker

centers.

Agar slant: Luxuriant, glistening, echinulate, mucoid growth with no pigment.

Sea-water broth: No pelliele, moderate turbidity, abundant, flocculent sediment.

Fresh-water broth; Scanty growth. Litmus milk: Decolorized, neutral, partly peptonized in 20 days.

Potato: Luxuriant, mucoid, creamy growth which darkens potato.

Indole not formed.

Nitrites not produced from nitrates. Acid but no gas from glucose, maltose,

xylose, and mannitol. No acid from glycerol, lactose, sucrosc, or salicin. Starch is hydrolyzed.

Hydrogen sulfide not formed.

Ammonia produced from peptone but not from urea.

Casein is digested.

Fats not hydrolyzed.

Aerobic, facultative.

Optimum temperature 20° to 25°C Source: Found associated with marine sedentary organisms.

Habitat: Not known from other sources.

16. Bacterium ammoniagenes Cooke and Keith. (Looke and Keith, Jour. Bact, 13, 1927, 315; Alcaligenes ammoniagenes Bergey et al., Manual, 3rd ed., 1930, 367.) From M. L. ammonia and Latin genero, develop.

Itods with rounded ends, 08 by 14 to 1.7 microns, occurring singly. Non-

motile, Gram positive,

Gelatin stab: No liquefaction Agar colonies: Circular, flat, smooth,

entire, gray.
Agar slant: Growth moderate, smooth, flat, opaque, glistening, butyrous, amor-

Broth: Moderate turbidity, with floc-

culent sediment.
Litmus milk: Slightly alkaline

Indole not formed.

No action on carbohydrates

Blood serum not liquefied.
Urea is fermented forming ammonia

Aerobic, facultative.

Optimum temperature 30°G.

Optimum temperature 30°G.
Source: From feees of infants.

Habitat Presumably widely dis-

17. Bacterium minutissimum Miguls (Racilius pyogenes minutisimus Kruse, in Flügge, Die Mikrorgamismen, 3 Auf. 2, 1886, 447; Bacterium pyogenes minutisimus Chester, Ahn Rept. Del. Col. Agr. Exp. Sts., 9, 1897, 87; Miguls, Syst. d. Bakt., 2, 1900, 448, Eberthelle minutisimus Bergy et al., Manual, 1st. ed., 1923, 228; Shigella minutisima Bergy et al., Manual, 3rd. ed., 1920, 270.) Tom Latin, smallest.

Description from Kruse (loc. cit.), Description not different from that of Bacillus tenuis sputigenes Pansini, according to Chester (Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 89).

Rods: 0.5 by 10 micron, occurring singly and in pairs. Non-motile,

Gram-positive.

Gelatin stab: No liquefaction. Yellowish growth spreading slightly on surface.

surface.
Growth on agar and blood scrum is not characteristic

Acid but no gas from glucose and lac-

tose. No characteristic odor.

No characteristic odor.

Not pathogenic for mice and rabilits.

Acrobic, facultative.

Optimum temperature 37°C. Source: Isolated from a facial abserss Habitat: Not known from other sources

18 Bacterlum Incertum Steinliaus (Jour. Buct , 42, 1941, 776 ) From Latin fneertus, uncertain.

Short rods 05 to 0.8 by 1.0 to 15 microns, occurring singly and occasionally in pairs. Young cultures motile, after 48 hours generally non-motile Gram-positive; after 18 hours many cells become Gram negative.

Gelatin stali: No liquefaction.

Agar colonies. Tiny, grayish-white, smooth, almost transparent. Does not grow well on nutrient agar.

North's gelatin chocolate agar slant; Falform, thin, transparent greath Brown color of chocolate medium changes to yellowish-green.

Blood agar Alpha homolysis at first;

after three days beta bemulysis.

Broth: Almost clear, very slight growth.

Litmus rulk: No clange.

Indole not produced

Hydrogen salf is not produced. Natrates not produced from nitrates

Starch not la drolyged

And but to gas from glucine, microse,

fructose, mannose, and maltose. No fermentation of lactose, rhamnose, galactose, mannitol, dulcitol, inositol, or sorbitol.

Voges-Proskauer test: Negative.

Microaerophilie.

Source: From the ovaries of the lyreman cicada, Tibicen linnei Smith and Crossbeck.

Habitat: Unknown.

19. Bacterlum imperiale Steinhaus, (Jour. Bact., 42, 1941, 777.) From Latin imperialis, referring to the imperial moth.

Small rods: 0.5 to 0.8 by 1.0 to 1.7 microns, occurring singly and in pairs. A few cells motile in young cultures. Gram-positive.

Gelatin stab: No liquefaction.

Agar colonics: Circular, entire, almost translucent, pinkish-orange to yellow pigment.

Agar slant: Filiform, glistening, opaque growth.

Broth: Slight to moderate turbidity; slight sediment.

Litmus milk. No change at first, later

slightly acid.

Potato. Heavy, glistening, moist growth, reddish to yellowish-orange.

Indolo not produced. Hydrogen sulfide not produced.

Nitrites not produced from nitrates.

Stareh not hydrolyzed.

Acid but no gas from glucose, sucrose, maltose, fruetose, manutoi, galactose, arabinose, xylose, saliein, raffinose, trehalose, sorbitol, mannese, adonitol, seculin, and slight acid from lactose and dextrin. Inulia, dulcitol, glycerol, rhamnose, adonitol, and inesitol not fermented.

Aerobic.

Source From the ahmentary tract of the imperial moth, Eacles imperialis Dru.

Habitat · Unknown.

 Bacterlum zopfil Kurth. (Kurth, Bericht. d. deutsch. Botan. Gesellschaft, 1, 1833, 97; Kurthia zopfii Trevisan, Atti della Accad. Fisio-Medico-Statistics in Milano, Sec. 4, 5, 1885, 92; Helikobacterium zopfii Escherich, Münch. med. Wehnschr., 55, 1886, 2, quoted from Enlows, U. S. Hygienic Lab, Bull. 121, 1920, 47; Bacterium (Proteus) zopfii Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 103; Bacillus zopfii Migula, Syst. d. Bakt., 2, 1900, 815; Zopfiis zopfii Wenner and Rettger, Jour. Bact., 4, 1919, 334.) Named for W. Zopf, German botanist.

This is the type species of the genus Kurthin Trevisan. (Trevisan, loc. cil.; Zopfius Wenner and Rettger, Jour. Bact., 4, 1919, 334.)

Rods: 0.8 by 3.5 microns, with rounded ends, occurring in long curved chains, Motile with peritrichous flagella. Gram-positive.

Gelatin eolonies: Radiate, filamentous, gray.

Gelatin stab: Arborescent growth in stab. No liquefaction.

Agar colonies: Fimbriate.

Agar slant: Spreading, gray, fimbriate growth.

Broth: Slow, moderate growth.

Litmus milk: No change.

Potato: Moderate, gray growth; medium becoming dark.

No II:S produced.

Indole not formed.

Nitrites not produced from nitrates Aerobic, facultative.

Optimum temperature 25° to 30°C. Habitat: Decomposing materials.

21. Bacterium zenkeri (Hauser) Chester. (Profeus zenkert Hauser, Ueber Faulnissbakterien, 1885; Bacillus zenkeri Trevisan, I generi e le specie delle Batteriacet, 1889, 17; Chester, Ann. Rept Del, Col. Agr. Exp. Sta., 9, 1897, 103; Zopfius zenkeri Wenner and Rettger, Jour. Bact., 4, 1919, 334; Bacillus procus-zenkeri Holland, Jour. Bact., 5, 1920, 220; Kurthio zenkeri Bergey et al., Manual, 2nd ed., 1925, 215.) Named for K. Zenker, German pathologist.

Rods, 0.55 by 1.6 to 2.3 microns, occurring in pairs and in chauss. Motile with peritrichous flagella. Gram-positive.

Gelatin colonies · Feathery, with filaments extending in all directions.

Gelatin stab: Surface growth like colonies. No arborescent growth in stab No liquefaction

Agar colonies: Thin, filamentous, spreading, gravish.

Agar slant: Thin, blush-gray, blamentous growth

Broth: Slightly turbed, with gray sediment.

Litmus milk: No charge.

Potato, Barely visible, yellowishgray, glistening growth.

Indole not formed.
Nitrites not produced from nitrates

No II S formed

Acrobic, facultative.

Optimum temperature 30°C. Habitat: Decomposing materials

Note: Wenner and Rettger, loc cit, consider the last two species to be identical.

Appendix I: The following Gram-positive, motile species may belong with the above group. All have been placed at one time of another in the genus Ackromobacter or in the genus Florobactersum

Small, oval rols, 03 to 95 b) 97 to 14 merons Motile, possessing peri trichous flagella Gram-positive

Geletin colonies Circules, grayish to transportent with irregular margin Geletin stab. Infundibulatoria lique-

Geletin stab Infundibulsions begarfactions
Again colonies Growth circular, gray,

smooth, glievening, with entire margin Broth Turbid with granular sediment Litting milk Congulated, poptonized, becoming alkaline Potato: Moist, glistening, grayish erouth.

Indole is formed.

Acid from glucose, sucrose, raffinose, sylose, mannitol and glycerol.

Pats are split in milk, giving rise to a rancid odor and a bitter taste Acrobic, facultative.

Optimum temperature 35°C.

Source. From the udder of a cow giving abnormal milk.

Habitat Milk

 Achromobacter stearophilum (Weinzurl) Bergey et al. (Bocillus stearophilus Weinzirl, Jour Med. Res., 59, 1919, 401, Bergey et al., Manual, 1st ed. 1923, 145)

Rode, 0.8 by 50 microns, occurring sancts. Mottle, Gram-nositive.

Gelatin colonies. Seanty development. Pumplin gelatin stab Filiform growth

ri stab. No liquefaction.

Pumpkin sgar colonica Small, smooth, convex, gray, entire

Pumpkin juice Slightly turbed, Pumpkin milk Acid, coagulated,

Potato Slight, smooth, gray, glisten-

Indole not formed

Natrices not produced from mitrates. No soid from tarbohydrate media. Starch from pumphin by drolyzed.

Aembic, facultative Optimum temperature 20°C,

Source Canned pumpkin Habitat Unknown

2 Achromobacter sulfureum Bergey et al. (Bakt. 1 Bubentschick, Cent. I. Bakt., 11 Abt., 72, 1927, 123; Bergey et al., Manual 3rd ed., 1930, 220.)

Rode 07 to 08 by 17 to 22 micrors, occurring singly and in poirs. Motile Gram positive.

Gefritin etab Sacente liquefection.

Apareolonies Circuler, proport-white, fat, Irmoperious

Ager stant Tillorn, grayshealite, amouth, homogeneous growth. Metallic luster. Broth: Turbid.

Litmus milk: Peptonized.

Potato: Yellowish-hrown layer. Indole not formed.

Nitrites produced from nitrates with gas formation.

Hydrogen sulfide formed.

Ammonia formed.

Urea is nttacked.

Methylene blue reduced.

Acrobic, facultative Optimum temperature 30° to 33°C.

Can grow at 0°C. Source: Sewnge filter beds.

Habitat: Putrefving materials.

NOTE: See Pseudomonas urcose Bergey et al. for another motile, Gram-positive organism described by Ruhentschick (Bakt. 3) from the same source.

4. Achromobacter aerophilum (Rubentschick) Bergey et nl. (Urobacterium oerophilum Rubentschiek, Cent f. Bakt., II Abt., 64, 1925, 168; Bergey et al., Manual, 3rd ed., 1930, 224.)

Rods: 0.75 to 0.85 by 2.0 to 4 5 microns, occurring singly, in pairs, and in chains, Motile. Gram-positive.

Urea gelatin colonies: Small, erreular,

dirty-gray, entire.

Uren gelatin stab. No liquefaction. Urea agar colonies: Circular, grayish, smooth

Urea agar slant : Dirty-gray, glistening

to dry growth.

Urea broth: Turbid. Urea milk: Unchanged

Urea potato Slight, grayish-wbite streak.

Indole not formed Nitrites produced from nitrates H.S not formed

Ammonia not formed. Aerobic, facultative.

Source: Sewage slime. Habitat: Putrefying materials.

5 Achromobacter citrophilum (Rubentschick) Bergey et al. (Urobactersum citrophilum Rubentschick, Cent f. Bakt , II Abt , 64, 1925, 168; 66, 1926, 161; 67, 1926, 167; 68, 1926, 327; Bergey et al., Manual, 3rd ed., 1930, 224.)

Rods: 0.75 to 0.85 by 2.5 to 6.0 microns, occurring singly and in pairs. Motile. Gram-positive.

Urea gelatin colonies: Small, gravish. white, smooth, undulate.

Urea gelatin stab: No liquefaction. Urea agar slant: Filiform, grayish-

white, thin, dry growth. Urea broth: Turbid.

Urea milk: Unchanged.

Urea potato: Dirty-gray, thin streak. Indole not formed.

Nitrites produced from nitrates Hydrogen sulfide not formed.

Ammonia not formed. Can derive ovygen from sodium citrate.

Aerobic, facultative. Optimum temperature 30°C. Source: Sewage alime. Habitat: Putrefying materials.

6. Flavobacterium sulfureum Bergey et al. (Bacterium punctans sulfureum Zettnow, Cent. f. Bakt., I Abt., Orig., 77, 1916, 222; Bergey et al., Manual, 1st ed., 1923, 103.)

Rods: 0.5 to 0.7 by 0.7 to 1.5 microas. Motile, possessing peritrichous flagella. Gram-positive.

Gelatin colonies: Very small, barely becoming brownish-yellow, visible. granular.

Gelatin stab: Spreading growth on the surface only. Later crateriform liquefaction.

Agar slant: Sulfur-yellow growth Broth: Turbid.

Litmus milk: Alkaline, peptonized, yellow.

Potato: Sulfur-yellow streak.

Indole not formed.

Nitrites not produced from nitrates. Blood serum: Sulfur-yellow growth. Partial liquefaction.

No acid from glucose. Aerobie, facultative

Optimum temperature 25°C.

Source: Air. Habitat: Unknown.

7. Flavobacterium acetylicum Levine and Soppeland. (Bull 77, Engineering Exp. Sta., Iowa State Agricultural College, 1926, 46 ) From the chemical term eccts1

Rods 0 9 by 1.1 microns, with rounded ends, occurring singly and in pairs

tile Gram-positive.

Gelatin stab: Stratiform liquefaction Agar colonies: Irregular in form, yel-

low, smooth, flat, amorphous, entire Agar slant: Abundant, echinulate growth, flat, peach yellow, smooth and

butyrous. Broth Ring growth on surface

bid with scant sediment.

Litmus milk. Slight acidity, with granular curd. Peptonization. Latmus reduced Potato Moderate, orange growth

Indole not formed Nitrites not produced from nitrates Starch by droly zed.

Blood serum honefied. Acid from glucose with formation of

acety lmethy learbinol. Acrolne, facultative

Optimum temperature 22°C Source: From skimmed milk

Habitat Unknown

a Flavobacterlum fuscum (Zimmermann) Hergey et al. (Bacillus fuscus Zimmermann, Bakt, unserer Triak- und Nutzwasser, Chemnitz, I, 1890, 70, not Racillus fuscus Hügge, Die Mikroorganismen, 2 Aufl., 1886, 200, Bactersom fuscus Chester, Ann Rept Del Col Agr. Lap Sta., 9,1897, 111; Berges et al . Manual, lat ed , 1923, 113, Chromobac terrum fuseum Topley and Wilson, Princ. Back and Immun. J. 1931, 405 ) From Latin fuscus, tawny

Rods 0.6 by 1.5 microns, occurring Non-motile Gram positive

Gelatin colonies boull, with brownish center and sellowish border

Gelatin stab: Gray, filiform growth in stab. Slow erateriform liquefaction.

Agar colonies: Circular, pale yellow, smooth, slightly convex, entire.

Agar slant: Growth greenish vellow, plumose, smooth, raised, undulate.

Broth: Turbid, with pellicle and sediment.

Litmus milk: Slightly acid, becoming alkaline, with yellow ring.

Potato: Thick, moist, chrome-yellow streak.

Indole not formed,

Nitrites produced from nitrates Acroble, facultative.

Ontimum temperature 30°C,

Source: From Zwonitz River water Habitat: Water.

8a. Baeterium fuseum liquefaciens (Dyar) Chester. (Bacillus fuscus liquefaciens Dyar, Ann. N. Y. Acad. Sci , 8, 1895, 375, Chester, Ann. Rept. Del. Col. Agr. Exp Sta., 9, 1897, 108.) Received from the Kral collection labeled Bacillus fuscus; nice from air. Differs from the above only in liquelying gelatin more slowly and completely.

9 Flavobacterium maris Ilarrison (Canadian Jour Research, 1, 1929, 232 ) From Latin mare, sea.

Rods 07 to 0.8 by 10 to 12 microns, occurring singly and in pairs At 37°C Non-motile. Encapsulated coccord Gram-positive.

Gelatia colonies: Punctiform, red orange, granular, entire,

Gelatin stab Red-orange surface growth, filiform growth in stab No Imuefaction

Agar colonies Circular, orange yellos, smooth, glistening, convex

Agar slant Growth moderate, orange. sellow, becoming cadminin orange to red-erange, spreading, glistening

Broth Clear with grange wellicle and ecliment

Litmus milk At first faintly alkaling. becoming faintly acid with country soils

Detain brant growth

Gelatin stab: Moderate, yellowish growth. Slight napiform liquefaction.

Agar colonies: Circular, convex, soft, becoming brittle, gravish, granular, en-

Agar slant: Scant, yellowish-white growth, becoming distinctly yellow.

Ammonia cellulose agar: Enzymatic zone shows a diameter of 2 to 3 mm at the end of 30 days.

Peptone cellulose agar: Enzymatic zone shows a diameter of 1.5 to 20 mm at the end of 30 days.

Broth: Turbid.

Filter paper broth: Paper reduced to thin, limp sheet which falls apart on slight agitation at end of 15 days.

Litmus milk: Acid. not digested. Potato: Abundant, moist, glistening, grayish-white growth, becoming distinctly yellow.

Indole not formed.

Nitrites produced from nitrates. Ammonia not produced.

Acid from glucose, maltose, lactose, starch and glycerol.

Aerobic, facultative. Optimum temperature 20°C. Source: Soil from California.

Habitat: Soil.

 Bacterium udum Kellerman et al. (Kellerman, McBeth, Scales and Smith, Cent. f. Bakt., II Abt., 39, 1913, 514; Cellulomonas uda Bergey et al., Manual, 1st ed., 1923, 166; Proteus cellulomonas var. Proteus udus Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 72.) From Latin udus growing in marshy ground.

Rods: 05 hy 15 microns. Non-motile. Gram-negative.

Gelatin stab: Liquefaction.

Agar slant: Luxuriant, faintly yellowish growth.

Cellulose agar. Enzymatic zone 0.5 mm wide.

Broth . Turbid. Litmus milk · Acid. Potato: Good growth Indole not formed. Nitritea produced from nitrates. Ammonia is produced.

Acid from glucose, fructose, arabinose, xylose, maltose, lactose, sucrose, dextria and starch.

Aerobic, facultative.

Optimum temperature 20°C.

Source: Compost from Arlington, Va. Hahitat: Soil.

24. Bacterium lucrosum McBeth. (McBeth, Soil Science, 1, 1916, 461; Cellulomonas lucrosa Bergey et al., Manual, 1st ed., 1923, 167.) From Latin lucrosus, lucrative.

Rods; 0.4 by 1.3 microns. Non-mo-

tile. Gram-negative.

Gelatin stab; No growth. Agar colonies: Circular, convey, semi-

transparent, granular, entire.

Agar slant: Moderate, flat, grayishwhite growth, becoming somewhat iridescent.

Ammonia cellulose agar: On crowded plate, the colonies show an enzymatic zone of 1 mm or more.

Peptone cellulose agar: Enzymatic zone 2 to 3 mm wide in 25 days.

Broth: Turbid.

Filter paper broth: Paper is reduced to a grayish-white pulpy mass whose fibers separate on slight agitation.

Litmus milk: No change.

Potato: No growth,

Indole not formed.

Nitrites not produced from nitrates. Ammonia not produced.

Acid from glucose, maltose, lactose, sucrose, starch and mannitol.

Aerohic, facultative.

Optimum temperature 20°C.

Source: Soil from California. Habitat, Soil.

25. Bacterium acidulum Kellerman et al. (Kellerman, McBeth, Scales and Smith, Cent. f. Bakt., II Abt., 39, 1913, 513; Cellulomonas acidula Bergey et al., Manual, 1st ed , 1923, 167.) From Latin acidus, acid.

Rods: 03 by 1.0 micron Non-motile.

Gram-negative.

Gelatin stab: No linuefaction.

Agar slant: Slight, gravish growth, Cellulose agar: L'nzymatic zone 0 5 to I mm in width.

Broth Clear.

Litmus milk: Acid. Potato: No growth.

Indole not formed

Nitrites not produced from natrates Ammonia not produced

Acid from glucose, maltose, lactore and aucrose. None from glycerol or mannitol

Starch not hydrolyzed

Acrobic.

Optimum temperature 20°C.

Source, Soil from Utah. Habitat: Soil

26 Bacterlum castigatum McBeth (McBeth, Soil Science, 1, 1916, 458; Cellulomonas eneligata llergey et al . Manual, lated , 1923, 168 ) From Latin

enstigatus, subdued Rods 04 by 1.2 microns Non-me-

Gram-negative. Gelatin stab. Moderate surface

growth. No liquefaction. Agar colonies. Circular, slightly con-

vex. brittle, gravish-white, granular, entire.

Ager slant, Abundent, glistening, gravish white growth.

Ammonia cellulose agar Enzymatic zone may attain a diameter of 2 5 mm in

Peptone cellulose agar Enzymatic gone may reach a diameter of 2 mm in 30 dass

Broth Slightly turbid.

Filter paper broth l'aper completely duntegrated and reduced to a pulp-like mass in 15 dass

Litmus milk: Acid, not digested. Indole not formed. Nitrites not produced from nitrates.

Ammonia not produced.

Acid from glucose, maltase, lactose, aucrose, starch and elycerol

Acrobic. Optimum temperature 20°C. Source: Soil from California Habitat, Soil.

27. Batterium bibulum (McBeth and Scales) Holland. (Bacillus bibulus Me-Beth and Scales, Bur of Plant Industry, U.S. Dept. of Arr., Bul. No. 266, 1913. 35. Holland, Jour. Bact . 5, 1920, 217 and 221; Cellulomonas bibula Bergey et al., Manual, 1st ed., 1923, 158.) From Laten bebulus, thirsty

Rods 04 by 13 microns, Motile, Gram-negative.

Gelatin stab. Crateriform houefaction. Cellulose agar colonics. Circular, convev, smooth, soft, grayish to faintly sellouish-white, finely granular, I'm-

symatic zone 0 3 mm in some cases. Agar slant. Luxuriant, glistening, smooth, moist, raised growth.

Broth Shehtly turbed. Latmus milk. Faintly acid.

Potato Smooth, glistening, canary relian Fronth.

Indole is formed Natrites not produced from natrates.

Ammonia is produced Acid from glucose, maltose, lactose, sucrose, starch, glacerol and mannitol,

Acrobic, facultative Optimum temperature 20°C.

Source From sever shores and culti-

sated soils.

Halatat Soil.

Appendix 1: The genus Cellularionas an originally proposed was based on a single physiological property and included such diverse types of lacteria as (1) pelar fingellate species, now placed in Pseudomonas, (2) Gram variable, non motile rule non placed in Corynelocterium, and (3) perituelious, non spore forming, Gram negative rode. Unfortunately the name is unsuitable for the third of these groups as that it has not been inserted in the outline used in this edition of the Maxi's acciptions of species previously placed in this genus are given lelow.

# Genus A. Cellalomonas Bergey et al. (Manual, 1st ed., 1923, 154.)

Small rods, with rounded ends, non-spore-forming, motile with peritrichous flagella, occurring in soil and having the property of digesting cellulose. Growth on ordinary culture media often not vigorous. Gram-negative.

The type species is Cellulamanos biazatea (Kellerman) Bergey et al.

## Key to the species of genus Cellulomonas.

- I. Motile with peritrichous flagella.
  - A. Gelatin liquefied. Chromogenic.
  - I. Milk acid.
    - a. Ammonia not produced; indole not formed.
      - 1. Cellulomonas biazotea.
    - Milk acid; digested.
      - a. Ammonia produced; indale not formed,
        - 2. Cellulomonas aurogenes.
      - aa. Ammonia produced; indole formed.
      - 3. Cellulomonas galba.
    - 3. Milk alkaline.
      - a. Ammonia produced; indole not formed.
    - 4. Cellulomonas folia.
    - Litmus milk unchanged.
      - a. Ammonia produced; indole not formed.

        5. Cellulomonas flava.
  - B. Gelatin liquefied. Non-chromogenic.
    - 1. Milk acid.
      - a. Ammonia not produced; indole not formed.
        - Cellulomonos celiasea,
           aa. Ammonia produced; indole not formed.
        - 7. Cellulamonas iugis.
      - aas Ammonia not produced; indole formed.

        8. Cellulomonas concitata.
      - 2 Milk acid: digested.
        - a Ammonia produced; indole not farmed.
        - 9. Cellulamonas caesia.
  - C Gelatin not liquefied. Chromogenic.
    - 1 Milk acid
      - a. Ammania produced; indole formed.
        - 10. Cellulomonas gilva.
    - 2. Milk alkalıne
      - a. Ammonia not produced; indale not formed.

        11. Cellulamonas ferruginea.
  - 11. Cellulamonas jeri D. Gelatin nat liquefied. Non-chromogenic.
    - 1 Milk acid; not digested
      - a. Ammonia not produced; indale not farmed.
        - Cellulomanas albida.
           Cellulomonas alma
      - aa. Ammonia not produced; indale farmed.
      - aa. Ammonia not produced; inidae la med.

        14. Cellulomanas desidiosa.
      - asa. Ammonia produced; indale not farmed.

#### 15. Cellulomonas pusilla. 16. Cellulomonas celida.

II. Motility not recorded

A. Gelatin liquefied Chromogenic.

I. Milk acid

a. Ammonia not produced. Acid from glucose.

17. Cellulomonas flaricena

as. Ammonia produced No seid from earbohydrates.

18. Cellulomonas rossica.

1 Cellulomonas biazotea (Kellerman et al ) Bergey et al. (Bacillus biazoteus Kellerman, McBeth, Scales and Smith, Cent. f. Bakt , II Abt , 39, 1913, 506; Bergey et al., Manual, 1st ed., 1923, 158; Proteus cellulomonas var. Proteus biazoteus Pribram, Klassifikation der Schizomyeeten, Leipzig und Wien, 1933,

This is the type species of the genus Cellulomonos.

Rods. 0 5 by 0 8 micron Motile with one to three peritrichous fingella

Gram-negative.

Gelatin stab, Liquefaction Agar elant, Luxuriant yellow growth Cellulose agar: Enzymatic zone 0.25

mm or less in width Peptone cellulose agar. No enzymatic

Broth Tuebid. Litmus milk Acid No curdling or

direction Potato Grove well.

Indole not formed.

Natrates produced from natrates Ammonia not produced

Acid from glucose, maltose, lactose,

sucrose, and glycerol. No acid from nanantol

Aerobie, facultative

Optimum temperature 20°C Source Soil from I'tale

Habitat Soil

2. Cellulomonas aurogenes (Kellerman et al ) Bergey et al (Bacillus auregenes Rellerman, McBeth, Seeks and Smith, Cent. f Balt , H Abt , 29, 1913, 505, Bergey et al , Manual, 1st ed , 1923, 157 ) From Latin and Greek, gold pro-

ducing

Rods, 0 t by 1.4 microns Motile with one to three peritrichous fingella Gram-negative Gelatin stab: Liquéfaction

Agar slant: Luxuriant yellow growth. Cellulose agar: Enzy matic zone 0 5 to 15 mm wide.

Broth: Turbid.

Litmus milk. Acid, digested

Potato, Luxuriant growth. Indole not formed.

Nitrites produced from nitrates, Ammonia produced

Acid from glucose, maltose, lactose, sucrose, starch and gly cerol. No acid from mannitol

Aerobie, facultative.

Optimum temperature 20°C. Source From soil from Louisiana and

Maine.

Habitat Soil

3 Celtulomonas galba (Kellerman et al) Bergey et al (Bacillus galbus

Kelterman, McBeth, Scales and Smith, Cent f Bakt, H Abt, 32, 1913, 309; Bergey et al., Manual, 1st ed., UC3, 157.) From Latin galbus, 3 cllow

Itods 04 by t 0 micron Motile with one to three pentuchous flagella. Gram pegative

Gelema stab Liquefection.

Agre slant Luxuriant yellow growth, Cellul-seager l'aramatic rone 0.5 min

in wulth. Broth Turbal

Literas ralk Acid, digested Petato No greath

Indicate Is formed.

Nitrites not produced from nitrates. Ammonia produced.

Acid from glucose, maltose, lactose, sucrose, starch and glycerol. No acid from mannitol.

Aerobic, facultative.

Optimum temperature 20°C. Source: Soil from Louisiana.

Habitat : Soil.

4. Cellulomonas folia Sanborn. (Jour. Bact., 12, 1926, 1 and 343.) From Latin folium, leaf.

Description from Sanborn (Jour. Bact., 18, 1929, 170) and also from his untuiblished notes.

Rods, 0.8 to 1.0 by 1.0 to 1.5 microns. occurring singly and in short chains. Motile with four to six peritrichous flagella. Gram-negative.

Gelatin stah: Slow crateriform liquefaction, becoming stratiform.

Agar slant: Growth moderate, dirtywhite, echinulate, raised, glistening,

opaque, butyrous. Broth: Turbid with yellowish sediment.

Litmus milk: Alkaline.

Potato: Thick, moist, yellowish-brown growth.

Indole not formed.

Nitrates produced from nitrates.

Acid and gas slowly produced from glucose, sucrose, glycerol and mannitol after prolonged incubation. No acid or gas from lactose.

Starch hydrolyzed.

Ammonia produced.

No H2S formed.

Aerobic, facultative. Optimum temperature 25° to 30°C

Resembles Cellulomonas rossica. Source: From decomposing leaves.

Habitat, Occurring in soil and active in decomposing leaves in composts, having the property of digesting cellulose.

5. Cellulon onas flava Sack. (Cent. f. Bakt., II Abt., 62, 1924, 79 ) From Latin flarus, yellow.

Rods: 02 by 1.5 microns. Motile.

Gram-negative.

Gelatin colonies: Circular, citron yellow.

Gelatin stah: Very slow liquefaction, Agar colonies: Large, circular, citron vellow.

Agar slant: Abundant, citron yellow streak.

Broth: Turbid with pellicle and sediment.

Litmus milk: Unchanged.

Potsto: Light brown streak. Indole not formed.

Nitrites and ammonia produced from

nitrates.

Hydrogen sulfide produced. Cellulose hydrolyzed. Aerobic, facultative.

Optimum temperature 20°C.

Habitat: Soil.

6. Cellulomonas cellssea (Kellerman et al.) Bergey et al. (Bacillus cellaseus Kellerman, McBeth, Scales and Smith, Cent. f. Bakt., II Abt., \$9, 1913, 508; Bergey et al., Manual, 1st ed., 1923, 153.)

Rods: 0.5 by 1.2 microns. Motile with one to three peritrichous flagella.

Gram-negative.

Gelatin stab: Liquefaction.

Agar slant: Limited grayish growth. Cellulose agar: Enzymatic zone 0 5 mm

or less.

Broth: Clear.

Litmus milk: Acid.

Potato: No growth.

Indole not formed. Nitrates not produced from nitrates.

Ammonia not produced.

Acid from glucose, maltose, lactose, sucrose, starch, glycerol and mannitol.

Aerobic, facultative. Optimum temperature 20°C.

Source: Soil from Utali.

Habitat Soil.

7. Cellulomonas iugis (McBeth) Bergey et al. (Bacillus iugis McBeth, Soil Science, 1, 1916, 456; Bergey et al , Manual, 1st ed , 1923, 158 ) From Latin, poined together.

Rods. 04 by 1,4 microns. Motile with

one to three peritrichous flagella. Gram-negative.

Gelatin stab: Napiform liquefaction. Agar colonies: Circular, convex, soft, grayish-white, granular, entire

Agar alant: Scant, grayish-white, filiform growth.

Ammonia cellulose agar, After 20 daya, all colonies show an enzymatic zone of 1 mm or more.

Peptone cellulose agar: Enzymatic zone continues to increase up to 30 days at which time it may reach 5 mm in width

Broth, Turbid.

Filter paper broth; After 15 days, the paper shows many ragged holes but disintegrates readily

latmus milk Acid, not digested

Potato: Ahundant, glistening, grayish-white growth.

Indole not formed

Nitrates produced from nitrates Ammonia produced.

Acid from glucose, maltose, factore, aucrose, starch, glycerol and mannitol Aerobic, facultative.

Optimum temperature 20°C Source, Soil from California Habitat Soil

8 Cellulomonas concitata (Melleth) Bergey et al (Bacillus concitatus Mc-Beth, Soil Science, 1, 1916, 448, Bergey et al , Manual, 1st ed , 1923, 159 ) | From Latin concitatus, rapid

Rods 05 by 1.2 microns Mobile with one to four perituchous fingella Gmm-negative.

Gelatin stab. Napiform liquefaction Agar colonies. Irregularly circular, decidedly convex, soft, becoming viscid, gravish-white, sometimes slightly fluorescent, granular, entire

Agar elant: Abundant, fiat, mosat, faint vellouish-white growth

Ammonia cellulose agar: Surface colonies show an enzymatic zone of 10 to 15 mm Deep colonies no sone but colony somewhat clearer than surrounding medium.

Peptone cellulose agar: Enzymatic zone, surface colonies, 2 to 2.5 mm; hottom colonies, 1 mm or less Broth: Turbid.

Filter paper broth: In 15 days, the paper is a disintegrated fibrous mass which retains its pure white color,

Latmus milk: Acid, not digested.

Potato: No growth.

Indole is formed.

Natrites not produced from nitrates. Ammonia not produced.

Acid from fructose, maltose, lactose, sucrose, starch and glycerol,

Aerobic, facultative,

Optimum temperature 20°C. Source: Soil from California.

Habitat: Soil.

9. Cellulomonas caesia (Kellerman et al ) Bergey et al. (Bacillus caesius Kellerman, McBeth, Scales and Smith, Cent J. Bakt , Il Abt., 59, 1913, 507; Cellulomonas caseia (sic) Bergey et al., Manual, 1st ed., 1923, 159; Cellulomonas cases (sie) Bergey et al . Manual, 4th ed ... 1931, 199.) I'rom Latin enearus, bluish. grav. Rods 04 by 1.5 mierons. Motile with

one or two perituehous fingella. Gramprestive

Gelatin stab. Laquefaction.

Beef agar streak, Moderate, flat, thin growth, slightly bluish fluorescence.

Cellulose agar Enzymatic zone, 05 to 10 mm in 15 days

Broth Turbid Slight sediment in 5 days.

Litmus milk Acid, digested

Potato No growth Indole not formed

Nitrates produced from nitrates

Ammonia produced Acid from glucose, maltose, lactore,

sucrose, starch, glycerol and mannitol. Acrolac, facultative

Optimum temperature 20°C,

Source: Soil from Louisiana, Wisconon and New Hampshire. Habitat-Soil.

 Cellulomonas gilva (McBeth) Bergey et al. (Bacillus gilvus McBeth, Soil "Science, 1, 1916, 453; Bergey et al., Manual, Ist cd., 1923, 160.) From Latin gilvus, pale vellow.

Rods: 0.5 by 1.5 microns. Motile with one to five peritrichous flagella.

Gram-negative.

Gelatin stab: Moderate, yellowishwhite surface growth. No liquefaction. Agar colonies: Circular, convex, hu-

tyrous, canary-yellow, sometimes with brownish rings, granular, entire.

Agar slant; Filiform, vellowish-white growth.

Ammonia cellulose agar: Enzymic zone not more than I mm. Entire colony semitransparent.

Peptono cellulose ngar: Enzymatic zono, 3 to 4 mm in 25 days.

Broth: Slightly turbid.

Filter paper broth: In 15 days, the paper is reduced to a thin, white filmy mass which disintegrates readily.

Litmus milk: Acid, not digested. Potato: Abundant, canary-yellow

growth.

Indole is formed

Nitrites produced from nitrates. Ammonia is produced.

Acid from glucose, maltose, lactose, sucrose, starch and glycerol. No acid from mannitol

Aerobie, lacultative Ontimum temperature 20°C.

Source Soil from California Habitat, Soil

11. Cellulomonas ferruginea (Rullmann) Bergey et al. (Bacillus ferrugineus Rullmann, Cent. f. Bakt., I Abt , Orig., 24, 1898, 465; van Iterson, Cent. f. Bakt., H Abt., 11, 1904, 691; not Bacillus ferrugineus Rullmann, Cent. f. Bakt., I Abt., 24, 1898, 467, Bergey et al., Manual, 1st ed., 1923, 150.) From Latin, rust-colored.

Rods 0 5 to 0 8 by 1.5 to 2.0 microns, occurring singly. Motile, possessing peritrichous flagella. Gram-negative.

Gelatin colonies: Brown, the pigment diffusing into the medium.

Gelatin stab: No liquefaction. Agar slant: Rusty-brown streak. Broth: Turbid.

Litmus milk: Dark-yellow ring; alkaline.

Potato: Rusty brown streak. Indole not formed.

Nitrites not produced from nitrates. Ammonia not produced.

Aerobic, facultative. Optimum temperature 25°C.

Habitat: Water.

12. Cellulomonas albida (McBeth) Bergcy et al. (Bacillus albidus McBeth. Soil Science, 1, 1916, 445; Bergey et al., Manual, Ist ed., 1923, 160.) From Latin albidus, white.

Rods: 0.4 by 1.0 micron. Motile with one to three peritrichous flagella.

Gram-negative.

Gelatin stab: Scant growth. No lique. faction.

Agar colonies: Circular, convex, soft, gravish-white, granular, entire. Agar slant: Scant, white streak.

Ammonia cellulose agar: After 30 days the colonics show an enzymatic zone of 1 to 2 mm.

Broth: Clear.

Filter paper broth: In 15 days, the paper is reduced to a thin, filmy, grayishwhite mass which readily breaks up.

Litmus milk: Slightly acid, not dirested

Potato: No growth

Indole not formed.

Nitrites not produced from nitrates. Ammonia not produced.

Acid from glucose, maltose, lactose, sucrose, starch, glycerol and mannitol.

Aerobic, facultative.

Optimum temperature 20°C. Source: Soil from California. Habitat: Soil.

13. Cellulomonas alma (McBeth) Bergey et al. (Bacillus almus McBeth, Soil Science, 1, 1916, 446; Bergey et al., Manual, 1st ed., 1923, 161.) From Latin almus, nourishing.

Rods, 0 5 by 1.2 microns Motile with one to five peritrichous flagella. Gramnegative.

Gelatin stab; Scant growth. No liquefaction.

Agar colonies: Circular, convex, soft, becoming brittle, grayish-white, granular, entire.

Ammonia cellulose agar Engamatic zone 3 to 4 mm in 25 days

Peptone cellulose agar. Enzymatie zone 2.5 to 3.5 mm in 30 days

Agar slant: Scant, gravish-white growth, becoming yellowish-white

Broth Shehtly turbid. Filter paper broth: Paper reduced to a loose felt-like white mass in 15 days Litmus milk: Slightly neid, not di-

Potato: No growth.

gested.

Indole not formed.

Nitrites not produced from nitrates Ammonia not produced.

Acid from glucose, maltose, lactose, sucrose, starch and glycerol. No seid from mannitol

Acrobic, facultative.

Optimum temperature 20°C. Source. Soil from California Habitat: Soil.

14 Cellulomonas desidiosa (McBeth) Breed (Bacillus desiduosus (sie) Me-Beth, Soil Science, 1, 1916, 450; Cellulomonas deciduosa (sic) Bergey et al, Manual, 1st ed., 1923, 162, Breed, in Manual, 5th ed., 1939, 495 ) From Latin desidiosus, inactive. Rods 04 by 10 micron. Motile with

one to three peritrichous flagella Gram-negative

Gelatin stab. Moderate growth. No liquefaction Agar colonies: Circular, slightly con-

vex, soft, becoming somewhat viscid, grayish-white, granular, entire.

Agar slant. Scant, flat, grayish-white growth.

Ammonia cellulose agar: Enzymatic zone 3 to 3 5 mm in 25 days.

Pentono cellulose agar: Enzymatic zone 1 to 2 mm around surface colonies. Bottom colonies frequently show no enzymatic zone until alter 20 days.

Broth: Slightly turbid. Filter paper broth: Paper is divided into gray white mass which readily disintegrates.

Latmus milk: Acid, not digested. Potato, No growth.

Indole is formed

Natrites produced from nitrates Ammonia not produced,

Acid from glucose, lactose, maltose and starch. No acid from mannitol, sucrose or glycerol.

Aerobic, facultativo.

Ontimum temperature 20°C Source Soil from California, Habitat Soil.

15. Cellulomonas pusilla (Kellerman et al ) Bergey et al. (Racillus pusilus (sie) Kellerman, McBeth, Scales and Smith, Cent. f Bakt., II Abt , 50, 1913, 513. Cellulomonas pusila (sic) Bergey et al , Manual, 1st ed., 1923, 161 ) From Latin pusillo, very small.

Rods. 06 by 1.1 microns. Motile with one to three peritrichous flagella. Gram-negative.

Gelatin stab. No liquefaction

Agar slant: Scant, grayish-white growth

Cellulose agar: Enzymatic zone 1 mm or less in width. Broth Turbid.

Litmus milk: Acid

Potato. No growth. Indole not formed.

Natrites produced from nitrates.

Ammonia is produced Acid from glucose, maltose, lactose,

sucrose, starch and glycerol. No acid from mannitol.

Acrobic, facultative.

Optimum temperature 20°C

Source: Soil from District of Columbia and South Carolina.

Habitat: Soil.

16. Cellulomonas gelida (Kellerman et al.) Bergey et al. (Bacillus gelidus Kellerman, McBeth, Seales and Smith, Cent. f. Bakt., II Abt., 39, 1913, 510; Bergey et al., Manual, 1st ed., 1923, 162.) From Latin gelidus, stift.

Rods: 0.4 by 1.2 microns. Motile with one to three peritrichous flagella.

Gram-negative,

Gelatin stab: No liquefaction.

Agar slant: Luxuriant, grayish-white

Cellulose agar: Enzymatic zone 1,5 mm in width.

Broth: Turbid.

Litmus milk. Acid, peptonized.

Potato: Grows well Indole not formed.

Nitrites not produced from nitrates.

Ammonia is produced.

Acid from glucose, maltose, lactose, sucrose, starch and glycerol. No acid from mannitol

Aerobic, facultative.

Optimum temperature 20°C. Source. Soil from Connecticut. Habitat Soil.

17. Cellulomonas flavigena (Kellerman and McBeth) Bergey et al. (Bacillas flavigena Kellerman and McBeth, Cent. f. Bakt., II Abt., 34, 1912, 488; Bergey et al., Manual, 1st ed., 1923, 125.) From Latin, yellow-producing.

Rods: 0.4 by 1.0 microea Motility not recorded. Gram-negatifla

Gelatin stab: Liquefactiont., Agar slant Luxuriant, yellon, growth. Cellulose agar: Enzymatic Goone 075

to 1.5 mm in width
Broth Turbid
Litmus milk; Acid
Potato: Grows well
Indole not formed
Nitrites produced from nitraites,
Ammonia not produced.
Acid from glucose, fructose, art binose.

xylose, maltose, lactose, sucrose, dextrin, starch, inulin, salicin, glycerol and mannutol.

Aerobic, facultative.

Optimum temperature 20°C.

Source: From contaminated culture, Habitat: Soil

18. Cellulomoaas rossica (Kellerman and McBeth) Bergey et al. (Bacillus rossicus Kellerman and McBeth, Cent I. Bakt., II Abt., 34, 1912, 492; Bergey et al., Manual, 1st ed., 1923, 157; Proteus cellulomonas var. Proteus rossicus Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 72.)

Rods: 0.3 by 1.2 microns. Motility not recorded. Gram-negative.

Gelatin stab; Rapid liquefaction.

Agar slant, Luxuriant, yellow growth. Cellulose agar; Enzymatic zone 0.5 to

1.0 mm in ridth.

Broth: Turbid.

Litmus milk: Alkaline

Potato: Grows well.

Indole not formed. Nitrites produced from nitrates.

Ammonia produced.

No said from carbohydrate media.

Aerobic, facultative.

Optimum temperature 20°C. Source, From contaminated culture. Habitat: Soil.

Appendix II: The following cellulosedigesting bacteria are not included above-

Achromobacter picrum Fuller and Norman. (Jour. Bact., 46, 1943, 276.)

From soil.

Bacillus aurogenes var. albus Kellerman, McBeth, Scales and Smith. (Cent. I. Bakt, II Abt., \$9, 1913, 506.) From soil from New York State. Differs from Cellulomonas aurogenes in that it shows no chromogenesis.

Bacillus rossicus var. castaneus Kellerman et al. (loc. cit., 508; Proteus cellu-

, gb.

zig unu mice,

from Maine, Connecticut and New York. Peritrichous. No liquefaction of gelatin. Chestnut relor on potato.

Bacillus subalbus Kellerman et al (loc.cit, 512) From soils from Ceorgis, Kentucky and New York

Appendix III: The following genus has been proposed for Cram-negative rods that utilize bacterial polysacchandes as a sole source of carhon

potato

## Genus .1 Saccharobacterium Sickles and Shaw (Jour. Bact , 28, 1931, 430)

Pleomorphic, non-mottle, non-spore-forming rods Gram-negative. Crow in meria solutions containing bacterial polyasceharides as the sole source of carbon Found in saamp and other uncultivated soils. Placed by the authors in the Family Mycobacteriaceae because of resemblances between these bacteria and those placed in Cylophago, Cellfalectual and Cellibrion. As the latter genera are no longer placed in this family, Saccharobacterium is placed temporarily in this appendix to the genus Bacterium near bacteris that decompose cellulose and agar

The type species is Saccharobacterium orale Sickles and Shaw

1 Saccharobacterium ovale Sickles and Shaw (Jour. Bact, 28, 1934, 422) From Latin ovum, egg, ellipse

Extremely pleomorphic Young cells ellipsoidal, 1 8 by 2 0 microns, usually in pairs, contain granules which stain deeply with basic deep offer cultures contain cells which may be from 12 to 15 microns long Non-motile. Grammeative.

No growth on ordinary media such as beef-extract agar, blood agar, beef-extract agar slants, nutrient gelatin, potato slants, litmus milk, beef-infusion broth and beef-extract peptone broth

Medium A plus pneumococcus II carbohydrate and 08 per cent agar. Vcry small, round, pink colonies, pinpoint is size after about 5 days. After 2 weeks 1 mm in diameter. Coherent

Litmus milk: No growth

Beef-extract peptone with 1 per cent sucrose Moderate turbidity Yellowish sediment.

Starch Hydrolyzed in Medium A containing pneumococcus II carbohydrate. Growth in lactore and sucrose broths Crowth in maltose, xyloso and destrin broths in some strains. No acid from inulin, mannitol, salicin and glucoss broths.

Racellus subalbus var. batatatis Keller-

man et al. (loc. cit , 513). From soil from

South Carolina Differs from the above

species in that it liquefies gelatin and

forms a very scant vellowish growth on

Aerobic.

Minimum temperature 20°C Optimum 34° to 35°C Maximum 37°C Thermal death point 54°C for 10 minutes. Minimum pH 6.4. Optimum pH 7.0

to 7.4. Maximum pH 7.8

Distinctive characters. The addition of 0.5 per cent sodium chloride to any favorable medium completely prevents growth of the organism (Medium A is that used by Dubos and Avery in 1931, (NH.)-SO<sub>4</sub>, 1 g, K<sub>2</sub>HPO<sub>4</sub>, 2.0 g, tapwater 1009 ml) Decomposes the carbohydrate of pneumoscoccus type II

Source: Swamps and other uncultivated soils

Habitat, Soil

 Saccharobacterium acuminatum Sackles and Shaw. (Jour. Bact., 28, 1934, 425) From Latin acuminare, to sharpen.

Extremely pleomorphic. Young organisms are pointed, often curved rods, 0.5 by 2 microns, having a densely staining granule. The tapering pointed ends remain unstained. Older cells have rounded ends, are apherical, pear-shaped or a long ellipsoid, stain weakly. Non-motile. Gram-negative.

No growth on ordinary media. See

preceding species.

Medium S with pneumococcus I carbohydrate and 0 8 per cent agar: Very tiny, pale yellow colonies. Less than 0.5 mm in diameter.

Starch not hydrolyzed.

Growth in sucrose broth. No growth in glucose, lactose, maltose, devtrin, inulin, mannitel and salicin broths.

Acrobic.

Minimum temperature 20°C. Optimum 28° to 32°C. Maximum 34°C. Thermal death point 48°C for 10 minutes. Minimum pH 6.0. Optimum pH 6.6

to 7.2. Maximum pH 7.8.

Distinctive characters: Decomposes the carbohydrate of pnoumococcus Type I. The nddition to any favorable medium of 0.7 per cent sodium chloride, of 0.3 per cent beef extract or 0 0.5 per cent peptone completely inhibits growth.

The composition of Medium S is as follows: MgSO 711,0,0 2 g, NILH-PO, 1.5 g, CaCl, 0.1 g, FeCl, tr, KCl, 0.1 g, 10 cc N/1 NaOH. Distilled water 1,000 ml, pH 7.2 to 7.4. To this was added the specific pneumococcus carbohydrate as a source of carbon in concentrations varying from 0.002 to 0.01 per cent.

Source: From swamps and other uncultivated soils.

Habitat. Soil.

28. Bacterium nenckil Biernacki. Biernacki, Cent. f. Bakt, II Abt., 29, 1911, 160; Achromobacter nenchri Berger et al., Manual, 3rd ed., 1930, 227.) Named for Noncki, a chemist at the Medical Institute in Warsaw.

Rods. 0.8 by 1.25 to 2.0 microps, with rounded ends, occurring singly and in pairs. Capsulated. Non-motile. Gram-negative. Gelatin colonies: Circular, convex, yellowish-white, granular.

Glucose and sucrose gelatin: Colonies larger and slimy.

Gelatin stab: No liquefaction.

Agar colonies: Circular, grayish white, glistening, concentric, finely granular.

Agar slant: The medium is liquefied Glucose and sucrose agar: Heavy slimy growth with gas. Faint fruity odor. Broth: Slightly turbid with gray sedi-

Broth: Slightly turbid with gray sediment and slight odor.

Litmus milk: Acid and gas formation. Potato: Slight growth.

Glycerol potato: Heavy growth with the appearance and consistency of cream.

Indole not formed.

Nitrites not produced from nitrates.

Acid and gas from glucose, fructose, galactose, maltose, sucrose, raffinose and mannitol.

Pruity odor in cultures
Facultative anaerobe.
Optimum temperature 37°C.
Source: From Spanish dried grapes
liabitat: Unknown

 Bacterium polysiphoniae Lundestad. (Lundestad, Cent. f. Bakt., 17
 Abt., 75, 1928, 331; Flagobacterium polysiphoniae Bergey et al., Manual, 3rd ed., 1930, 152.) From Greek, many tubes.

Rods: 0.5 to 0.6 by 2.0 to 4.0 microns, with rounded ends, occurring singly. Non-motile. Gram-negative.

Fish-gelatin colonies: Circular, slightly glistening, bright yellow, transparent, with denser center.

Fish-gelatin stab: Slight yellowish grouth on surface. Slow saccate liquefaction.

Sea-weed agar colonies: Circular, flat, with concentric rings, diffuse margia, light yellow Agar is disintegrated.

Fish-agar slant: Yellow, flat growth, with undulate margin

Broth. Turbid with flocculent pellicle and yellowish sediment.

Indole not formed.

Nitrites not produced from nitrates No action on carbohydrates Slight hydrolysis of starch Aerobic, facultative Optimum temperature 30°C Source: Sea nater of Norwegian Coast Habitat: Sea nater.

30 Bacterium droebachense Lundestad (Lundestad, Cent f Bakt, II Abt, 1928, 290; Flaubacterium droebachense Bergey et al, Manual, 3rd ed, 1930, 153; Pzeudomanas droebachense Stamer, Jour Bact, 42, 1941, 544) Latinized, from Dröbak, where this oreanism was isolated.

ganism was isolated.
Rods 05 to 06 by 20 to 26 microns, with rounded ends, occurring singly

Non-motile Gram negative Fish-gelatin colonies Small, circular, compact, opaque, glistening, orangevellow.

Fish-gelatin stab Liquefaction infundibuliform becoming stratiform

Sea-weed agar colonies Small, circular, flat, opaque, glistening, orangevellow. Agar is disintegrated

Fish-agar slant Flat, opaque, glistening, slimy, orange-yellow, entire growth Broth Slight flocculent turbidity, yellow.

Indole not formed

Nitrites not produced from nitrates Starch hydrolyzed

Slow growth on surface of glucose agar

Acrobic, facultative

Optimum temperature about 37°C Minimum temperature 5° to 10°C Maximum 40°C

Stamer (loc ett) identified cultures soldted from sea water on the Parthe Coast as belonging to this species some injuefied gelatin white others did not Nitrates were reduced. A vellow membraneous pellicle was formed on broth, and the temperature range is given as 5° to 35°C. Optimizin 25°C. Ille creamed the organism Pseudomonas.

droebachensis, but reported it nonmotile.

Source From sea water at Drobak on the Norwegian Coast

Habitat Sea water

31. Bacterium delesseriae Lundestad (Lundestad, Cent f Bakt, II Abt, 75, 1928, 332; Flavobacterium delesseriae Bergey et al., Manual, 3rd ed., 1930, 153)

Rods. 05 to 0.6 by 16 to 26 microns, with rounded ends, occurring singly Non-motile Gram-negative

Fish-gelatin colonies Circular, transparent, glistening, concentrically ringed, yellow

Fish-gelatin stab, Crateriform liquefaction, with yellow sediment

Sea-weed agar colonies Circular, flat, concentrically ringed, light yellow Agar is disintegrated

Fish-agar slant No growth

Broth. Turbid with flocculent pellielo and sediment, light yellow

Indole not reported. Nitrites not reported

No action on earbohydrates Slight hydrolysis of starch

Acrobic, facultative Optimum temperature 23°C

Source Sca water of Norwegian Coast. Habitat Sca water

32 Bacterium boreaic Lundestad (Lundestad, Cent f Bakt, 1I Abt, 75, 1928, 333, Flatebacterium boreale Bergey et al, Manual, 3rd ed., 1930, 154) From Latin boreals, northern

Rods 05 to 06 by 16 to 26 microns, with rounded ends, occurring singly Non-motile Gram negative

Fish-gelatin colonies Circular, opaque, glisteming, concentrically ringed, vellow

Fish gelatin stab Yellow, with crateriform liquefaction

Sea-water ager colonies Circular, flat, opaque, glistening, diffuse margin, light yellow Agar is disintegrated Fish-agar slant: Yellow, flat, glistening, opaque, entire growth.

Broth: Finely flocculent, yellow sedi-

Indole not reported.

Nitrites not reported.
No action on carbohydrates.

Slight hydrolysis of starch.

Acrobic, facultative.

Optimum temperature 23°C. Source: Sea water of Norwegian Coast. Habitat: Sea water.

33. Bacterium ceramicola Lundestad. (Lundestad, Cent. f. Bakt., II Abt., 75, 1928, 332; Flavebacterium ceramicola Bergey et al., Manual, 3rd ed., 1933, 151.)

From Greek, living in earthenware, Rods: 0.5 to 0.6 by 1.4 to 2.4 microns, with rounded ends, occurring singly and lying side-by-side. Non-motile. Gramnegative.

Fish-gelatin colonies: Circular, glis-

tening, transparent, yellow.
Fish-gelatin stah: Slight, yellow surface growth. Liquefaction crateriform.
Sea-water agar colonics: Circular, flat.

Sca-water agar colonics: Circular, flat, transparent, glustening, diffuso margin, light yellow. Agar is disintegrated.

Fish-agar slant: Moderate, yellow, flat, entire, glistening, opaque growth. Broth: Light yellow pellicle and sediment.

Indole not reported.

Nitrites not reported
No action on carbohydrates.
Slight hydrolysis of starch

Acrobic, facultative. Optimum temperature 23°C

Source: Sca water of Norwegian Coast.

Habitat: Sea water

 Bacterium rhodomelae Lundestad, (Lundestad, Cent f. Bakt., II Abt., 75, 1928, 331; Flatibacterium rhodomelae Bergey et al., Manual, 3rd ed., 1930, 146.)

Rods: 0.5 to 0.8 by 1.2 to 2.0 microns, with rounded ends, occurring singly, in

pairs, and at times in short chains. Motile. Gram-negative.

Fish-gelatin colonies: Circular, slightly glistening, opaque, white.

Fish-gelatin stab: Rapid infundibuliform liquefaction.

Sea-weed agar colonies: Circular, flat, thin, transparent, glistening, entire.

Agar is dissolved.
Glucose agar slant: Moderate growth,
white, becoming orange-yellow, flat, un-

dulate margin, opaque, glistening.

Broth: Turbid, with pellicle and gray-

Broth: Turbid, with pellicle and gray ish-yellow, slimy sediment.

Indole not formed.

Nitrites not produced from nitrates. No action on carbohydrates.

Very slight hydrolysis of starch. Aerobic, facultativo.

Optimum temperature 20° to 25°C. Source: Sea water of Norwegian Coast. Habitat: Sea water.

35. Bacterium alginovorum Waksman, Carey and Allen. (Jour. Bact., 28, 1934, 215.) From M. L., alginic and Latin 2020, devour.

Rods: 0.75 to 1.2 by 1.5 to 2.0 microns, with rounded to almost clliptical ends, especially when single, occurring frequently in pairs and even in chains. Actively motile. Capsule-forming. Gram-negative.

Alginic acid plate: Colony large, white in appearance with coarse granular center, entire margin. Clears up turbidity caused by the alginic acid on plate No odor.

Alginic acid liquid medium: Heavy pelliele formation. Active production of an enzyme, alginase, which brings about the disappearance of alginic precipitate in sea water medium.

Salt nater medium: A slimy pellicle of a highly tenacious nature is produced, the whole medium later turning to a soft jelly.

Sea water gelatin: Active and rapid fiquefaction in two to six days, at 18°C;

highly turbid throughout the liquefied zone.

Agar liquefaction: Extensive softening of agar, no free liquid.

Sea water glucose broth. Abundant umform turbidity, with surface pellicle: some strains give heavier turbidity and

others beavier pellicle

Litmus milk containing 3 5 per cent salt: No apparent growth

Potato moistened with sea water Most, spreading growth, ivory-colored. heavy sediment in free liquid at the bottom

Starchplate Abundant, cream-colored, slimy growth; extensive diastase producfion

Aerobic, microaerophilic

Optimum temperature 20°C

Source. From sea water, sea bottom sediments and from the surface of algal growth in the sea.

Habitat, Very common in the sea

36 Bacterlum fuctcola Waksman. Carey and Allen (Jour. Bact , 28, 1934, 213) From Latin fucus, scawced and cola, da eller

Short rods: 06 to 10 by 10 to 15

microns, with ends rounded to almost coccoid; slightly curved Actively motile, with twirling motion Gram-negative.

Alginic acid plate. Colonies finely granular, entire; at first whitish, turning brown in three to five days, and later almost black, producing a deep brown soluble pigment

Alginic acid liquid medium Limited growth on surface in the form of a pellicle Frequently produces no growth at all.

Sea water gelatin · Active liquefaction: no growth in stab, thin, fluorescent growth throughout liquefied zone

Agar liquefaction, Positive, although limited; only softening of agar.

Sea water glucose broth Faint turbidity; no pelliele, no sediment Latmus milk containing salt. No ap-

parent crowth. Potato moistened with sea water No.

growth.

Starch plate No growth. Acrobic

Optimum temperature 20°C. Source. From sea water near the sur-

face of the sand bottom Habitat: Rare in sea water

Appendix I: Additional agar-digesting hacteria placed in genera other than Bacterrum

- I. Achromobacter
  - A Motile with peritrichous flagella
    - 1 Nitrites produced from nitrates
      - 1. Achromobacter pastinatar.
- II. Agarbacterium.
  - A. Non-motile
    - 1. Nitrites produced from nitrates.
      - 2 Agarbacterium bufo
  - B Motile, but position of flagella not recorded
    - 1 Nitrites produced from nitrates
      - 3. Agarbacterium reducans
    - 4 Agarbacterium viscosum 2 Nitrites not produced from natrates
      - - 5. Agarbactersum mesentericus.
        - Agarbacterium aurantiacum. 7. Agarbacterium cyanoides
    - 3. Seven additional species that are numbered but not named

### III. Flavobacterium.

- A. Non-motile.
  - 1. Nitrites produced from nitrates.
    - 8. Flavobaclerium uliginosum.
- B. Peritrichous flagella.
  - 1. Nitrites produced from nitrates.
    - 9. Flavobacterium amocontactum.

1. Achromobacter pastinator Gorealine. (Jour. Bact., 26, 1933, 412.) From Latin pastinator, one who digs a trench.

Short rods: 0.4 by 1.5 microns, occurring singly and in pairs. Motile with two to five peritrichous flagella. Gramnegative.

Plain gelatin stab: No growth. Nutrient gelatin stab: Surface growth

very seanty. No liquefaction.

Nutrient ngar colonies: At first tiny, nlmost colorless, becoming yellowish and ring-like. Agar liquefied rapidly.

Nutrentngarshaut. Growth good, flat, not thick. Agar liquefied along streak often to the depth of n quarter of an inch. Pocket formed nt bottom of slant filled with n rather viscous, yellowish fluid.

Nutricut broth. Slight turbidity after 5 days Subsurface but no surface growth. No sediment.

Litmus milk Slightly neid after 20 days. No curd Only a trace of reduction at bottom of tube

Potato: No grouth

Indole not formed

Natrates produced from natrates.

No H2S produced

Acid from ambinose, glucose, galactose, lactose, fructose, maltose, mannose, melezitose, pectin, raffinose, rhamnose, salicin, sucrose, starch and dextrin. No growth in dulcitol, crythritol, mannitol, sorbitol, glycerol, vylose and inulm. Starch is hydrolyzed.

Limits of growth: pH 59 to 90.

Temperature relations: Optimum 28°C. Good growth at 25°C. Moderate growth at 20° and 37°C. No growth at 10° and 42°C.

Facultative anaerobe

Distinctive characters: Digests agar

rapidly; colonies sink through to the glass of the Petri dish. Fehling's solution reduced by the liquefied agar. Considerable change in viscosity of agar due to the digestion.

Source: From a trickling filter receiving creamery wastes.

Habitat: Probably widely distributed in nature.

 Agarbacterlum bufo Angst. (Puget Sound Biol. Stn. Pub., 7, 1929, 49.)
 Short rods with rounded ends, 0.6 by

0.8 micron, occurring singly and in pairs. Non-motile. No capsules. Gram-negative.
Fish gelatin stab: Stratiform liquefac-

tion, growth best at top.

Fish gelatin colonies: Circular, crateri-

Fish gelatin colonies: Circular, cratenform, granular.

Fish agar slaut: Abundant, filiform, raised, glistening, opaque, yellow, membranous growth. Fish agar colonies: Circular, concen-

trically ringed, sunken, entire, granular, yellow to orange.

Digests agar; cellulose not attacked.

Potato: No growth.

Plain milk unchanged, surface growth yellow.

Does not produce H<sub>z</sub>S or indole. Nitrites produced from nitrates

Acid from mannitol. No acid from xylose, rhamnose, arabinose, glucose, sucrose or lactose.

Starch not hydrolyzed.

Aerobic.

Optimum temperature 25° to 28°C.

Maximum under 36°C.

Source Isolated from Odonthalia kamtschattea.

Habitat: On marine algae.

 Agarbacterium reducans Angst. (Puget Sound Biol. Sta. Pub , 7, 1929,

Short rods with rounded ends, 0 6 by 0.8 micron, occurring singly and in pairs Motile. No capsules Gram-negative.

Fish gelatin colonies. Circular, sunken, entire, erateriform, granular

Fish gelatin stab. Crateriform liquefaction, growth only near surface

Fish agar slant. Abundant, filiform, flat, glistening, smooth, opaque, white, butyrous growth.

Fish agar colonies: Moderate, circular, smooth, flat, entire, granular, white to buff or colorless

Digests agar, cellulose not attacked.
Fish broth Turbid, no sediment, no surface growth.

Potato. No growth

Nitrites produced from nitrates

No H<sub>1</sub>S or indole formed Plain milk unchanged

Acid from sucrose, arabinose, rhamnose and mannitol No acid from xylose or lactose

Starch is hydrolyzed.

Aerobic.

Optimum temperature 25° to 28°C, thermosensitive.

Source Isolated from Nercocustis

Source Isolated from Nercocysuluetheana,

Habitat On marine algae

4 Agarbacterium viscosum Angst (Puget Sound Biol Sta. Pub, 7, 1929, 49.)

Short rods with rounded ends, 06 to 08 micron, occurring singly or in pairs Motile No capsules Gram-negative Fish gelatin colonies Circular, sunken,

entire, crateriform, granular
Fish gelatin stab Stratiform hquefse

tion, growth best at surface
Fish agar slant Abundant, raised,

glistening, smooth, opique, gray, vesicular, viscid growth

Fish agar colonies Circular, con-

toured, raised, lohate, granular, fluoreseent green

Digests agar; cellulose not attacked

Fish broth. Floeculent pelliele, turbid, no sediment, fluorescent green.

Potato Abundant, filiform, glistening, smooth, yellowish-brown, butyrous growth.

Natrites produced from nitrates

No H<sub>s</sub>S or indole formed. Plain milk unchanged; surface growth

greenish

No acid from rhamnose, sucrose, lactose, mannitol, xylose or arabinose Starch is hydrolyzed. Acrobic.

Optimum temperature 20° to 28°C; thermoscusitive.

Source: Isolated from Iridaea cordata. Habitat. On marine algae,

5 Agarbacterium mesentericus Angst. Puget Sound Biol Sta. Pub. 7, 1929.

(Puget Sound Biol Sta. Pub , 7, 1929, 49 ) Short rods with rounded ends. 0.6 by

0 8 micron, occurring singly or in pairs.

Motile No capsules Gram-negative
Fish gelatin stab. Infundibuliform

liquefaction, growth best at top Gelatin colonies. Circular, sunken,

irregular, crateriform, granular,
Fish agar slant Abundant, filiform.

raised, glistening, finely wrinkled when old or dry, opaque, buff, membranous growth

Fish agar colonies Circular, concentrically ringed, flat, entire, granular, white to buff

Digests agar, cellulose not attacked. Fish broth Membranous pellicle, moderate clouding, no sediment.

Potato Spreading, raised, glistening, wrinkled, buff to yellowish, membranous growth

Does not produce H.S or indole.

Natrates not produced from natrates Plant mulk unchanged

And from mannitol No and from xylose, rhamnose, arabinose, glucose or lactose

Starch is hydrolyzed.

Acrobic.

Optimum temperature 20° to 28°C; thermosensitive.

Source: Marine algae; isolated from Nercocustis luetkeana.

Habitat: On marine algae.

6. Agarbacterium aurantiacum Angst. (Puget Sound Biol. Sta. Puh., 7, 1929, 49.)

Short rods with rounded ends, 0.6 to 0 8 micron, occurring singly or in pairs. Motile. No capsules. Gram-negative. Fish gelatin colonies: Circular, sunken. crateriform, entire.

Fish gelatin stab: Stratiform liquefac-

tion, no growth along line of stab. Fish agar slant: Abundant, filiform, flat, glistening, smooth, opaque, orange,

butyrous growth. Fish agar colonies: Circular, smooth,

flat, crose, sunken, granular.

Digests agar; cellulose not attacked. Fish broth: Membranous pellicle, turbid, no sediment.

Plain milk unchanged; surface growth .920270

Potato: Abundant, filiform, flat, dull, smooth, orange, butyrous growth.

Nitrites not produced from nitrates. No H.S or indole formed.

Acid from lactose and mannitol, No acid from xylose, rhamnose, arabinose, glucose or sucrose.

Starch not hydrolyzed.

Aerobic.

Optimum temperature 20° to 28°C; thermosensitive

Source: Isolated from Porphyra perforata.

Habitat: On marine algae.

7. Agarbacterium cyanoides Angst. (Puget Sound Biol. Sts. Pub., 7, 1929, 49.)

Short rods with rounded ends, 0.8 by 1 4 microns, occurring singly or in pairs. Motile. No capsules Gram-negative Fish gelatin colonics: Circular, sunken,

entire, crateriform, granular Fish gelatin stab Stratiform liquefac-

tion, growth only at top Fish agar slant. Abundant, filiform, raised, glistening, smooth, opaque, gray, butyrous growth.

Fish agar colonies: Circular, smooth, flat, lobed, granular, greenish to yellowish.

Digests agar; cellulose not attacked. Fish broth: Flocculent pellicle, turbid,

nn sediment, fluorescent green. Potato: Abundant, filiform, raised, glistening, smooth, buff, butyrous growth.

Nitrites not produced from nitrates. No HaS ar indole formed.

Plain milk acidified, greenish surface growth.

Acid from sucrose. No acid from xylose, arabinose, glucose, lactose, mannitol or rhamnose.

Starch is hydrolyzed.

Aerobic. Optimum temperature 20° to 28°C;

thermosensitive. Source: Isolated from Iridaea cordata. Habitat: On marine algae.

Note: Seven additional species are described with as much detail by Angst (loc. cit.) as are the six above species; but he refers to them only as Agarbacterium Nos. 5, 6, 7, 8, 9, 13, 14, and 15. All digest agar.

 Flavobacterium uliginosum ZoBell and Upbam. (Bull, Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 263.) From Latin uligo, ooze or moist mud.

Rods: 0.4 tn 0 6 by 1.2 to 3 9 microns, some slightly curved, occurring mostly singly with some short chains. Nonmotile. Gram-negative.

All differential media except the freshwater broth, litmus milk, and potsto were prepared with sea water.

Gelatin colonies: 1 mm, orange, annken.

Gelatin stab: Infundibuliform lique. faction. Yellow pigment. Gelatin discolored brown.

Agar colonies: Sunken, uneven, irregular, gummy colonies which liquely agar. Produces arange to yellow pigment and discolars agar brown.

Agar slant: Luxuriant, yellowish-

orange, glistening, filiform, adherent growth which slowly liquefies agar

Sca-water broth: Dense yellow pellicle, moderate turbidity, slightly viscid sediment

Fresh-water broth: No visible growth. Litmus milk. Completely decolorized, neutral

Potato. No visible growth

Indole not formed

Nitrates rapidly reduced to mtrites Produces acid but no gas from xylose, glucose, maltose, lactose, sucrose and salicin. Does not ferment glycerol or mannitol.

Starch not hydrolyzed.

Hydrogen sulfide not formed

Ammonia produced from peptone but not from urea.

Casein digested

Fats not hydrolyzed

Agar liquefied rapidly However, after prolonged laboratory cultivation this organism gradually loses its ability to digest agar.

Aeroble, obligate.

Optimum temperature 20° to 25°C Source Marine bottom deposits

9. Flavobacterium amocontactum Zo-Bell and Allen. (Jour Bact , 29, 1935, 246) I'rom Latin amo, to love and contactus, touching, contacting

Slender rods 0.4 to 0.7 by 16 to 2.3 merons, with rounded ends, occurring singly and in irregular clumps. Stunvery lightly. Possess well-defined capsules. Actively metile by means of perticious flagella. Gram-negative

Gelatin stab: Good filiform growth with rapid saccate liquefaction

with rapid saccate Inquefaction
Agar colonies: Circular, 2 0 to 4 0 mm
in diameter, 3 ellow

Agar slant Abundant, filiform, rmooth, ghstening, abundant, bright yellow growth having a butyrous consistency. Originally liquefied agar, but this property was lost following artificial cultivation.

Sea water broth: Good growth with ring at surface Strong turbidity and abundant viscid sediment. No odor. Milk: No growth.

Potato: No growth.

Potato dialyzed in sea water: Slight yellow growth.

Indole not formed.

Nitrites produced from nitrates.

Ammonia liberated from pertone.

Hydrogen sulfide produced.

No acid from glucose, lactose, sucrose, vylose or manutol.

Starch not attacked.

Optimum reaction pH 8.0.

Optimum temperature 18° to 21°C. Facultative aerobe.

Distinctive character; Adheres firmly to submerged glass slides; cannot be removed with running water.

Source. Many cultures isolated from glass slides submerged in sea water.

Habitat: Sea water.

Appendix II: Another species described recently is:

Bacillus exedens Wieringa (Wierniga, Jour. Microbiol. and Scrol., 7, 1941, 121, Bacillus agar-exedens Wieringa, idem) From stable manuro, leafmold and soil. Liquefics agar.

37 Bacterium chitinophilum Nock, (Jour Manne Res, 4, 1941, 103) From M L, chitin and Greek philos, laying. Short rods 0 35 to 0 65 by 0 95 to 1.5 microns. Motile Gram-negative.

Sea water gelatin. Liquefaction; growth absent in stab but abundant in

Inquefied zone
Sea water agar plate. Colonies eireu-

Sea water agar plate. Colonies circular, smooth, entire, raised, white.

See water liquid medium. Moderate growth, sometimes with formation of ring or pellicle. Scant granular sediment.

Decomposes natural chitipous material

such as horseshoe erab shells and also purified chitin.

Four out of five strains produce ni-

Acid from glucose and usually from sucrose, glycerol and mannitol. One of five cultures produced acid from lactose. Does not direct cellulose. Does not hydrolyze starch.

Does not produce hydrogen sulfide. Aerobic.

Optimum temperature 20°C.

Source: From the shell of a decomposing horseshoe crab, Linulus polyphemus, and from the intestinal tracts Venus mercenaria, Ovalipes occilatus, Mustelus mustelus and Spheroides maculatus.

Habitat: Gommon in marine sand, mud and water.

38. Bacterium chltinochroma Hock. (Jour. Marine Res., 4, 1941, 105.)

Short rods: 0.45 to 0.75 by 0.90 to 1.4 microns. Motile, Gram-negative.

Sea water gelatin: Active liquefaction; no growth in stab, but thick bright yellow growth throughout the liquefied zone.

Basic agar plate: Colonies circular, smooth, entire, raised, varying in color from lemon to deep orange.

Basic liquid medium: Abundant growth with production of pellicle. Scant granular sediment, increasing with age of culture.

Decomposes natural chitinous material such as horseshoe crab shells and also purified chitin.

Does not produce nitrites from ni-

trates.

Acid from glucose and sucrose, but not lactose, glycerol and mannitol.

Does not digest cellulose. Hydrolyzes starch.

Does not produce hydrogen sulfide. Aerobic

Optimum temperature 20°C

Source From the intestinal tract of the squid, Loligo pealers Common.

Habitat Marine sand, mud and water.

Appendix I: The first species of chitinovorous bacteria that was described and named was placed in the genus Bacillus because it was a motile rod.

1. Bacillus chitinororus Benecke. (Bot. Zeitung, 63, 1905, 227.) From M. L. chitin, chitin; vorus, devouring. Rods: 0.75 by 2.0 microns. Sometimes in pairs and chains. Motile with peritrichous flagella. Gram-negative.

Gelatin stah; Liquefaction,

Mineral agar containing chitin: Good growth if no sugar is added to produce acid. Non-chromogenic.

Peptone mineral agar containing chitin: Good growth if reaction is neutral to slightly alkaline.

Salt in concentrations up to 11 per cent is favorable for growth. Maximum 4 per cent.

Peptone broth: Turbid with heavy, slimy, whitish to brownish nellicle.

Nitrites produced from nitrates. Ammonia produced in peptone-chitin media.

Acid from glucose and sucrose Optimum temperature 20°C.

Source: Isolated at Kiel from media containing decomposing orab shells and from media containing purified chitin; also from soil.

Habitat: Brackish water and soil.

Notes Bacillus tumescens Zopf, Bacillus cohaerens Gottheil, Bacillus pricus vulgaris Kruse, Bacillus coli communs Sternberg, Bacillus coli communs Sternberg, Bacillus megatheruum De Bary, Vibrio aqualilis Gunther and Spirillum rubrum von Esmarch dd not attack chitin under the conditions tested by Benecke (loc. cit).

Benton (Jour. Bact, 29, 1935, 449) describes but does not name 17 types of entinovorous bactern isolated from water, mud and plankton of fresh water lakes, from decaying May fly nymbells, intestinal contents of fish, frogs, bats, snipe, and crayfish. Also shore soil, composts, etc. Twelve types are reported to be monotrichous, two are peritrichous and three, position of flagella not stated. Of two Gram-positive types, one may have been a spore-former and the other a Corynebacterium. Two types digested cellulose

ZoBell and Rittenberg (Jour. Bact., 55, 1933, 275) isolated and studied but did not name 31 cultures of chitinoclastic bacteria from marine sources Out of 16 cultures studied intensively, all were Gram-negative. All but 4 of the 31 cultures were motile. One culture was a coccus and two species were vibrios None digested cellulose

\*39 Bacterium phosphoreum (Colm) Mohsch (Micrococcus phosphoreus Cohn, see letter addressed to J Penn, Verzameling van stukken betreffende het geneeskundig staatstoezicht in Nederland, 1878, 126, Bacterium phosphorescens l'ischer, Cent 1, Bakt , 3, 1888, 107, Photobacterium phosphorescens Beijerlnck, Arch Neerl d Sci Exactes, 23, 1889, 401, Streptococcus phosphoreus Trevisan, I generi e le specie delle Batteriacec, 1889, 31, Bacillus phosphoreus Mace, Traité de Baet , Paris, 4th ed , 1901, 995, Micrococcus phosphorescens Chester, Man Determ Bact , 1901, 181, Molisch, Dio Leuchtende Pflanzen, 1012, 66, Photobacter phos phoreum Benerinck, Folia Microbiologica, Delft. 4, 1916, 15, Photobacterium phosphoreum Pord, Textb of Bact, 1927, 615)

Description from Pischer (loc cit) Coccobacilli Occur frequently as zooglea Non-motile Stain lightly with aniline dyes

Gelatin No liquefaction Gelatin streak Grav-white growth

Broth No growth Milk No growth

Potato No growth

Perments earlichydrates Blue-green phosphorescence

Minimum temperature 5°C Maximum 25°. Optimum for luminescence

10°C Aerobic, facultative

Source Isolated from luminous fish Habitat Found commonly on dead fish, meat, etc

40 Bacterlum phosphorescens indigenus (Eisenberg) Chester (Linheimischer Leuchtbacillus, Fischer, Cent f Bakt , 3, 1888, 107; Photobacterium fischers Beuerinck, Arch Néerl d Sci-Exactes, 23, 1889, 401; Bacillus fischeri Trevisan, I generi e le specie delle Batterinece, 1889, 18, Bacillus phosphorescens indigenus Lisenberg, Bakt. Diag . 3 Aufl . 1891, 124; Vibrio fischeri Lehmann and Neumann, Bakt, Diag., I tufl , 2, 1896, 312; Chester, Ann. Rept. Del Col Agr Exp Sta , 9, 1897, 121; Microspira fischeri Chester, Man. Determ Baet , 1901, 333, Spirillum phosphoreseens Holland, Jour. Bact . 5, 1920. 225, Vibrio phosphoreseens Holland, ibid , 226, Achromobacter fischeri Bergey et al , Manual, 3rd ed , 1930, 220 )

Description from Fischer (loc. cit )

Short thick rods 0.4 to 0.7 by 1.3 to 21 microns, with rounded ends, occurring singly and in pairs. Motile Stain with the usual anilino dyes

Johnson, Zworvkin and Warren (Jour. Bact , 46, 1913, 167) made pictures with the electron nucroscope of a culture which they identify with this species. The organisms have a tuft of polar flagella, indicating that this species belongs in the genus Pseudomonas

Gelatin stab Liquefaction Gelatia colonies Liquefaction one week, circular, I mm in diameter,

Broth No growth. Milk No growth

Blood serum No growth Potato No growth.

Cooked fish Abundant growth tire surface covered with a gray-white, slimy, phosphorescent mass

Temperature relations Minimum 5° to 10°C Optimum 22°C.

Acrobic

Source Prom sea water at Kiel and from herring.

<sup>\*</sup> Dr. Frank H. Johnson, Dept. Bieteriology, Princeton Univ., Princeton, New Jersey, assisted in preparing the section on phosphorescent bacteria, May, 1946

Habitat: Live on dead fish and in sea water.

41. Bacterium hemophosphoreum Pfeisser and Stammer. (Pfeisser and Stammer, Ztschr. f. Morph. u. Oköl. d. Tiere, 29, 1930, 136; Brucella (?) haemophosphoreum Pribram, Klassiskation der Schizomyeeten, Lespzig und Wien, 1933, 67.)

Rods: 1.0 by 4.5 microns, the size varying with the medium. Seem to show bipolar staining.

Fish agar with 3 per cent sea salt: Good growth.

Litmus milk: Acid. Reduction.

Potato: Yellow growth, medium be-

Indole not formed.

Nitrites not produced from nitrates. Acid from glucose, sucrose, lactose, mantose, galactose, mannitol and fruc-

Phosphorescent.

Pathogenic for other insects.

Source. Isolated from the blood of diseased larvae of the mealworm, Tenebrio molitar.

Habitat: From diseased insect larvae.

Appendix I: The following phosphorescent species have been described in the literature. Many are incompletely described and they have been placed in various genera without adequate study.

Achromobacter argenteophosphorescens (Katz) Bergey et al (Bacillus argenteophosphorescens I, Katz, Cent. 1. Bakt., 9, 1891, 157; Bacterium argenteophorescens Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 121; Bacillus argenteo-phosphorescens Migula, Syst. da. Bakt., 2, 1900, 860; Photobacillus I, Miquel and Cambier, Traité de Bestu, Paris, 1902, S81; Bergey et al., Manual, 3rd ed., 1930, 221) From sea water in Elizabeth Bay, Sydney, Australia. Silver-white luminescence Probably a variety of Photobacterium fischeri Beijerinek, according to Katz.

Achromobacter cyaneophosphorescens

(Katz) Bergey et al. (Bacillus cyaneophaspharescens Katz, Cent. f. Bakt, 9, 1891, 158; Photobacterium cyaneum Lud. wig, according to Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 331; Photobacterium eyano-phosphorescens (sie) Ford, Textb. of Bact., 1927, 619; Vibrio cyanco-phosphorescens Lehmann and Neumann, Bakt. Diag., 7 Aufl., 2, 1927, 543; Bergey et al., Manual, 3rd ed. 1930, 221.) From sea water in Little Bay, near Sydney, Australia. Bluishgreen luminescence. Identical with or similar to Photobacterium indicum Beijerinck, according to Katz.

Achromobacter luminosum Bergey et al. (Bacillus argenteo-phorphorescens II, Katz, Cent. 1. Bakt., 9, 1801, 157; Bacterium argenteo-phosphorescens Migula, Syst. d. Bakt., 2, 1900, 455; Photobacilus II, Miquel and Cambier, Traité de Bact., Paris, 1902, 882; Bergey et al., Manual, 3rd ed., 1930, 226.) From fish obtained in the market. Greenish-silver luminescence.

Achramobatter phosphoreum (Nigus)
Bergoy et al. (Bacillus argenteo-phospharescene liquefacions Katz, Cent. f.
Bakt., 9, 1831, 187; Bacillus phosphoreus
Nigula, Syst. d. Bakt., e, 1900, 507;
Bergey et al., Manual, 3rd ed, 1930, 222.)
From sea water along the coast near
Sydney, Australia. Luminescene
night. Probably identical with Photobatterium luminosum Beigrinck;

Achromobacter phosphoricum (Migult)
Bergey et al. (Bacillus argenteo-phosphoreacens III, Katz, Cent. f. Bakt., 9,
1891, 157; Bacillus phosphoricus Migult)
Syst. d. Bakt., 2, 1900, 870; Photobacillus
III, Miquel and Cambier, Traité de
Bact., Paria, 1902, 882; Bergey et al,
Manual, 3rd ed., 1930, 223.) From
cuttlofish (Sepia sp.) obtained in the
fish market. Bluish-greenish-white
luminescence.

Achromobacter smaragdinophosphorescens (Katz) Bergey et al. (Bacillus smaragdino-phorphorescens Katz, Cent. f. Bakt., 9, 1891, 159; Bacterium smaragdino phosphorescens Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1807, 121, Bacterium smaragdina-phosphorescens Migula, Syst. d Bakt., 2, 1900, 435; Bacterium smargadinum (sic) Chester, Man Determ Bact., 1901, 181, Berge, et al., Manual, 3rd ed., 1930, 225) From hering in a fish market in Sydney, Australia. Green luminescence Probably identical with Photobacterium phosphorescens Bujirinok.

Bacillus fachers Dyar (Dyar, Ann N Y. Acad. Sci. 8, 1803, 370, Bacterium fachers Chester, Man Daterin Baet, 1901, 165) Dyar added to the confusion in the nomenclature of phosphorescent organisms by giving this name to four cultures received by him from the Krall collection labeled Photobacterium phosphorescens, Photobacterium ballicium, Photobacterium fischeri and Photobacterium fischeri

Bacterium chronomi Issatschenko (Bulletin du Jardin Impérial botanique & St Pétersbourg, 11, 1911, 37, Photobacterium chronomi Issatschenko, ibid, 43) A phosphorescent bacterium from a genus of midges. Chronomus

Bacterium giardi (Kruse) Billet (Giard and Billet, Compt rend Soc Biol , Paris, 1889, 593, Photobactersum pathogenicum Giard, quoted from Eigkmanu, see abst in Cent f. Bakt, 12, 1892, 056, Photobactersum grands Kruse, m Plugge, Die Mikroorganismen, 3 Aufl. 2, 1896, 333, Bacillus phosphorescens giardi Kruse, 1dem, Bacterium phosphorescens grardi Chester, Ann Rept Del. Col. Agr. Exp. Sta , 9, 1897, 125, Billet, Bull Sci France et Belguque, 21, 1898, 144, Bacterium phosphorescensgiardi Chester, Man Determ Bact, 1901, 182 ) Pathogenic for marine crustaccans

Bacterium hippanici Issatschenko (loc. cit., 47). From fresh water fish Bacterium lucens (van Treghem) Nucsch (Micrococcus lucens van Treghem) Nucsch, Karsten's Deutsche Flora, 1880; quoted from Ludwig, Cent f Bakt. 2, 1887, 378) From lummous meat Considered identical with Bacterium phasphoreum

Bacterium luminosia (Beljerinck) Chester (Pholobocterium luminosium Beijerinck, Arch. Néerl. d Sci Evactes, 23, 1839, 401; Vibro luminosius Beijerinck, Bot. Zeit , 1839, 733, according to Trevisan, I generi e le specie delle Batteriacce, 1839, 23, Bactilus luminosius DeToni and Trevisan, in Saccardo, Sallem Evance e sterio

Syst d Bakt., 2, 1900, 1915; Photobacter lumnosum Beijerinek, Folia Microbiologica, Dellt, 4, 1916, 15.) From sea water.

Bacterium pelagia Dubois (Dubois, Compt rend, Acad Sci, Paris, 107, 1888, 502 and 111, 1890, 363; Bacillus pelagia Dell'oni and Trevisan, in Saccardo, Sylloge Fungorium 8, 1889, 959.) Isolated from the surface of Pelagiae postiticas.

Bacterium pfluegers Ludnig (Ludnig, Zucht., i. wissensch. Mikrosk., 1, 1881, Micrococcus pflagers. Ludnig, Hedwiga, No. 3, 1884, Arthrabacterium pflugers Delbary, 1837, Photobacterium pflugers Beijerinck, Cent. 1. 1844, 6, 1890, 617, Bacterium phosphorecesers pflugers Chester, Ann Rept. Del Col. Agr Exp Sts. 9, 1897, 125) From fish and meat. Considered identical with Bacterium phosphoreum

Bacterium pholas Dubois (Compt rend. Acad. Sci., Paris, 107, 1888, 502.) Isolated from Pholadis dactyli

Bacterium phosphorescens Hermes (Hermes, Sitzingsber naturi, Freunde, April 19, 1887, quoted from Cent. f Bakt. 2, 1887, 401; Bacillus hermen Trevisan, I genon e le specie delle Batternace, 1889, 18) From sea water. Mace (Traité de Bact, Para, 4th ed, 1901, 901) says this may be the same as Microsoccus phosphoreus Cohn. Emerald-green luminesecence.

Bacterium phosphorescens gelidus (Eisenberg) Chester. (Phosphorescirenden Mikroorganismen, Forster, Cent. f. Bakt., 2, 1857, 337; Bacillus phosphorescens geltdus Eisenberg, Bakt. Diag., 3 Aufl., 1891, 182; Chester, Ann. Rept. Del. Col. Agr Exp Sta., 9, 1897, 125.) From phosphorescent sea fish. Fischer (Cent. f. Bakt., 4, 1888, 89) states that this organism is the same as his Bacterium phosphorescens.

Coccobacillus acropoma Yasaki and Haneda. (Yasaki and Haneda, 1936; quoted from Harvey, Living Light, Princeton, 1940, 33.) From a fish (Acro-

poma japonicum).

Coccobacillus coclorhynchus. (Studied by Hsu, Sci-i-kai Mcd. Jour., 56, 1937, 1; queted from Harvey, Annual Rev. of Biochem., 10, 1941, 543) From a deepsea fish (Coclorhynchus 5p.).

Coccobacillus ikiensis. (Quoted from Harvey, Living Light, Princeton, 1940,

263.)

Coccobacillus loligo Kishıtani. (Kishitani, Proc. Imp. Acad. Tokyo, 4, 1928, 69; quoted from Harvey, Living Light, Princeton, 1940, 35) From the squid (Loligo edulis).

Micrococcus cyanophos. (Studied by Claren, Ann. d. Chemie, 535, 1938, 122, quoted from Harvey, Living Light,

Princeton, 1940, 184)

Micrococcus physiculus. (Quoted from Harvey, Living Light, 1940, 34) The cause of luminescence of a fish

(Physiculus japonicus)

Microspira phosphoreum Yasaki. (Yasaki, see Sci-i-kai-zasabi, 45, 1926; quoted from Harvey, Living Light, 1940, 239.) Caused luminescence of a freshwater shimp in Japan

Photobacter hollandiae Beijerinck. (Proc. Sect. Sci. Kon Akad. v. Wetensch., Amsterdam, S. 1900, 352.) Similar to Photobacterium luminosum.

Photobacter hollandicum Beijerinek.
(Folia Microbiologica, Delft, 4, 1916, 15)
Photobacter hollandicum partum

Beijerinck (Folia Microbiologica, Delft, 4, 1916, 15)

Photobacter splendidum Beijerinck. (Beijerinck, Proc Sect. Sci., Kon. Akad. v Wetensch., Amsterdam, 3, 1900, 352; Vibrio splendidus Lehmann and Neumann, Bakt. Diag., 7 Auft., 2, 1927, 543; Photobacterium splendidum, quoted from Harvey, Living Light, Princeton, 1910, 204.) May be a variety of Photobacterium indecum.

Photobacter splendor maris Beijerinek. (Proc. Sect. Sci., Kon. Akad. v. Wetensch., Amsterdam, 3, 1900, 352.) May be a variety of Photobacterium

indicum.

Photobacterium Beijerinek. (Beijerinek, Arch. Néerl. d. Sci. Exactes, 23, 1889, 401; Photobacter Beijerinek, Proc. Sect. Sci., Kon. Akad. v. Wetensch, Amsterdam, 3, 1900, 352; Photospirillum Miquel and Cambier, Traité de Bact., Paris, 1902, 885; Photomonas Orla-Jensen, Jour. Bact, 6, 1921, 271.) Photobacterium phosphorescens is the type species of this genus See Bacterum phosphoreum. Several species are placed in this genus by Fischer.

Photobacterium annulare Fischer. (Fischer, Ergebnisse d Plankton-Expedition d. Humboldt-Stiftung, 4, 1894, 41; Microspira annularis Migula, Syst

d Bakt., 2, 1900, 1014 ) From sea water. Photobacterium balticum Beijerinek. (Einheimischer Leuchtbacillus, Fischer, Cent. f. Bakt., 8, 1888, 105; Beijerinek, Akad. v. Wetenschappen, Afdeel. Natuurk., 2de Recks, 7, 1890, 239; see abst. in Cent. f. Bakt., 8, 1890, 617; Vibrio balticus Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 341.) From water of the Baltic Sca. The relationship of Photobacterium balticum to Bacterium phosphorescens andigenus is not clear. The former species is based on a culture sent by Fischer to Beijerinek labeled Linheimischer Leuchtbaeillus Beijerinek considered to be different from his Photobacterium fischeri.

Photobacterium caraibicum Fischet. (Fischer, loc. cit., 1891, 41; Microspira caraibica Migula, loc. cit., 1015.) From

sea water

Photobacterium coronatum Fischer.
(Tischer, loc. cit , 41; Microspira coronata

Migula, loc. cit, 1013.) From sea water.

Photobacterium degenerans Fischer (Fischer, loc. cit., 37; Microspira degenerans Migula, loc cit, 1015, Bacillus degenerans Beijerinek, Folia Microbiologica, Delft, I, 1912, 1) From sea water

Photobacterium delgadense Fischer (Fischer, loc. cit., 37; Microspira delgadensis Migula, loc. cit., 1014) From sea water.

Photobacterium glutinosum Fischer (Fischer, loe cit, 41; Microspira glutinosa Migula, loc. cit, 1014) From sea water.

Photobacterium hirsutum Fischer (loc. cit., 41). From marine fish

Photobacterium popillare l'ischer (Fischer, loc ett , 41; Microspira papillaris Migula, loc ett , 1016) From sea water.

Photobacterium sepuae (Quoted from Doudoroff, Jour Bact, 44, 1912, 151, who obtained a culture so labeled which had come from Prof Kluyver's collection at Dellt)

Photobacterium tuberosum Fischer (Incher, loc. ett., 37; Microspira tuberosa Migula, loc. ett., 1014, Photobacter tubereulatum Beljerlack, Folia Microliologica, Delft, 4, 1916, 15) From sea water

Water
Pseudomonas toyamensis (Quoted Irom Harvey, Living Light, Princeton, 1910, 263)

Sarcina noctifuca Heller (Heller, Arch. f. Physiol., path Chem u Mhr., N.F., f. 1833-51, 44; see Harvey, Iaving Light, Princeton, 1910, 6.) From fish Possibly the same as Bacterium phosphoreum Molisch.

42 Bacterium erythroglocum Rubland and Grohmann, (Cent. f. Bakt., 11 Abt., 61, 1921, 256.) From Greek erythros, red and glota, glue.

Rode 0 5 by 2 0 microns Non motile Grun prestive.

Gelatin plate Red, droplet like colonies.

Gelatin stab: No liquefaction.

Agar plate: Red, droplet-like colonies.

Agar slant. Raised, non-spreading,
glistening, brick-red growth

Potate. Abundant, brick-red, warty.

Facultative autotroph.

Oudizes hydrogen in an inorganic medium under an atmosphere of  $\Pi_z$ ,  $\Omega_z$ , and  $\Omega\Omega_z$  Produces a pellicle on the inorganic liquid medium

Source Calcarcous soil,

Habitat. Probably widely distributed in soil

43 Bacterium Ientulum Grohmann (Cent f Bakt, II Abt, 61, 1921, 256.)

Rods 05 by 1 to 2 microns. Motile by long thin peritrichous flagella. Gramnegative.

Gelatin plate, Colonies appear like

milk droplets. Gelalin stab No liquefaction.

Agar plate Tough, other yellow colonies about 7 mm in diameter. Agar streak Parchment-like, folded,

yellow streak about 1 cm broad.
I'otato Heavy, yellow growth

l'otato Heavy, yen Aerobic

l'acultative autotroph

Oudizes hydrogen in an inorganic medium under an atmosphere of H<sub>1</sub>, O<sub>2</sub>, and CO<sub>2</sub>. Produces a heavy folded pellicle on the morganic liquid medium. Source, Soil poof in lime

Habitat Probably widely distributed in soil

41 Bacterium leucogloeum Rubland sud Grohmann (Cent f Bakt, 11 Abt, 61, 1921, 236) From Greek leukos, white and glota, glue

Rods 05 by 07 to 52 (?) microns
Motile by means of peritrichous flagella.
Gelatin stab. No liquefaction.

Agar streak Wide, show, wet, ivorycolored growth

Potato Gray brown slime.

Aerolac

l'acultative autotroph

Oxelizes by lrogen in an inorganic medium under an atmosphere of H<sub>1</sub>, O<sub>1</sub>. and CO2. Produces a pellicle on the inorganic liquid medium.

Source: Calcarcous soil

Habitat: Probably widely distributed in soil.

\*15. Bacterlum stewartii Erw. Smith. (Sweet corn bacillus, Stewart, N. Y. Agr. Evp. Sta. Bul. 130, 1897, 423; Pseudomonas stewarti Smith, Proc. A. A. A. Sci., 47, 1898, 422; Smith, Bact. in Rel. to Plant Dis., 3, 1914, 89; Aplanobacter stewarti McCulloch, Phytopeth., 8, 1918, 440; Bactilus stewarti Holland, Jour. Bact., 6, 1820, 220; Phytomonas stewartii Bergey et al., Manual, 1st ed., 1923, 192.) Named for F. C. Stewart, American plant pathologist.

Description from Smith, U. S. Dept. Agric., Div Veg Phys. and Path., Bul.

28, 1001.

Rods, 04 to 07 by 09 to 2.0 microns. Capsules Non-motile (McCulloch, loc. cit.) Gram-negative.

Gelatin: No liquefaction

Nutrient agar colonies Small, round, yellow colonies. Broth: Growth feeble with whitish

ring and yellow precipitate.

Milk: Yellow ring but no visible action on the milk. Slightly acid.

Mitrites not produced from nitrates. McNew (Phytopath., 28, 1938, 773) states that less virulent strains assimilate only organic nitrogen; those of intermediate virulence assimilate nitrogen from morganic salts without reduction of nitrates to nitrites; virulent strains reduce nitrates to nitrites

Hydrogen sulfide not formed

Indole production slight or none.

Reduction of methylene blue in Dunham's solution feeble or doubtful

Acid but no gas from glucose, galactose, sucrose, mannitol and giyeerol. No acid from maltose. Acid from Iructose, arabinose and xylose (McNew, loc ct.) Starch not hydrolyzed.

Optimum temperature 30°C. Maximum 30°C. Minimum 8°C.

Optimum pH 6.0 to 80. Limits about pH 4.5 to 85.

S per cent salt restricts growth.

Strict zerobc. Source: From wilted sweet corn.

Source: From wilted sweet corn. Habitat: Pathogenic on corn, Zea mays.. Sweet corn very susceptible and field corn slightly so.

46. Bacterlum tardicrescens McCulloch. (McCulloch, Phytopath., 27, 1937, 135; Phytomonas tardicrescens Burkholder, Phytopath., 27, 1937, 617.)
From Latin, slow growing.

Rods: 0.6 to 0.8 by 1.58 microns. Motilo with a polar flagellum. Gram-nega-

tive.

Gelatin: No liquefaction.

Beef-extract agar colonies: Circular, mustard yellow, edges entire, 1 to 1.5 mm in diameter.

Broth: Light clouding.

Milk: Slightly alkaline. Clearing after 5 to 6 weeks.

Nitrites are produced from aitrates. Indole not produced.

No II S produced or feebly so.

Acid but no gas from glucose, fructose, galactose, arabinose, xylose and rhamnose. Alkaline reaction from salts of citric, malie and succinic acid.

Starch is not hydrolyzed.

Not hpolytic (Starr and Burkholder, Phytopath., 32, 1942, 603).

Optimum temperature 26°C. Maximum 32°C. Minimum 5°C (McCulloch Phytopath., 28, 1938, 648).

Optimum pH 6.5 to 7.5. Growth shight at 5.8 and 8.0 (McCulloch, loc cit.).

No growth with 3 per cent salt (Mc-Culloch, loc. c:t.).

Aerobic.

Distinctive character: Very slov grower.

<sup>\*</sup>The section covering species of interest to plant pathologists has been pre pared by Prof. Walter H. Burkholder, Cornell Univ , Ithaca, New York, May, 1916.

Source: Isolated by McCulloch and by Burkholder from blighted iris leaves. Habitat: Pathogenic on Iris app

47. Bacterium albilineans Ashby. (Ashby, Trop. Agr., Trinidad, 6, 1929, 135; Phytomonas albilineans Magrou, in Hauduroy et al., Diet d Bact Path . Paris, 1937, 326.) From Laten, produc-

ing white streaks. Description taken from Martin, Carpenter and Weller, The Hawanan

Planters' Record, 36, 1932, 184 Rods: 0 25 to 0.3 by 0 6 to 1 0 micron, occurring singly or in chains Motile with a polar flagellum. Gram-negative

Agar colonies: After 7 to 10 days, minute transparent drops, moist, shining. Honey yellow to Naples yellow

Gelatin: No liquefaction.

Milk: Growth, but no visible change in the milk,

No growth with ammonium solts, mtrates, or asparagine as a source of nitrogen.

No growth in reptone water without carbohydrates, secreted Invertasc Starch is not hydrolyzed

Optimum temperature about 25°C Maximum 37°C.

Distinctive characters: Differs from Xanthomonas vascularum which produces a large gummy type of colony, and which is a very active organism brochemically The two pathogens also differ in the type of lesion they produce on sugar cane.

Source: Isolated by D. S. North (Co-Ionial Sugar Ref. Co. Sidney, N.S. Wales, Agr. Rept , 8, 1926, 1) from white stripe and leaf scald of sugar cane in Australia.

Habitat: Vascular pathogen of sugar cane, Saccharum officinarum.

Appendix I: The following species have been described from diseased plant tissues but may not, in some cases at least, have been the cause of the disease. Bacıllus betae Migula. (Kramer, Oes-

terreich. landwirtsch Centralb., 1891,

Heft 2 and 3; Migula, Syst. d Bakt., 2. 1900, 779.) The cause of a disease of the sugar beet (Bela vulcaris).

Bac. carpophyllacearum Dufrenov (Compt rend. Soc Biol., Paris, 81, 1918, 920; probably there is an carlier reference to this species ) On Dianthus, Saponarsa and Lychnis

Bacillus coffercola Steyacrt. (Rev Zoo. et Bot. Afr , 22, 1932, 137.) From nodules on coffee roots

Bacillus lacerans Migula. (Bacillus a, Busse, Ztschr f. Pflanzenkr., 7, 18-72. Migula, Syst. d Bakt., 2, 1900, 780.) From diseased sugar beets.

Bacillus maculicola Delaeroix. (Delacroix. Compt. rend. Acad. Sci. Paris. 140, 1905, 680, Bacterium maculicola Stanp, in Sorauer, Handb d Pflanzenkrankheiten, 5 Aufl , 2, 1928, 276; Aplanobacter maculicola Elliott, Manual Bact. Plant Path , 1930, 8, Phytomonas nicotranae-tabaci Magrou, in Hauduroy et al . Dict d Bact, Path , 1937, 386.) From diseased spots on leaves of tobacco,

Bae. nucleophyllus Dufrency (Compt. rend Soc. Biol., Paris, 81, 1918, 920, nomen nudum ) On Rhododendron ferruaineum

Bac, tritici Dufrenoy (Compt rend. Soc. Biol , Paris, 81, 1918, 920, nomen nudem, not Pseudomonas tritici l'intchinson. India Dent. of Agr . Bact. Ser . 1, 1917, 174 ) On wheat

Bacillus vitis Montemartim Patol. Veg. S. 1913, 175 ) Pathogenic on the grape (Vitis vinifera)

Bacterium apis Brizi. (Lav e Relaz. d Reg Staz di Patol Veg , Roma, Gennio-Giugno, 15, 1896 and Atti R Accad Naz. Lincel, Rend Cl Sc. Fis. Math e Nat, Ser 5, 6, 1897, 233) Motele. From rot of celery.

Bacterium betge Chester. (Bacterial parasite, Arthur and Golden, Indiana Agr. Exp. Sta., Bull 30, 1892, 61; Chester, Ann Rept. Del Col. Agr. Exp. Sta . 9. 1807, 129; Bacellus arthurs Migula. Syst. d. Bakt., 2, 1900, 681 ) Motile From diseased sugar beet tubers.

briosianum Pavarino. Racterium

(Attı del. R. Accad. Naz. Lincei, Rend. Cl Sci. Fis, Math. et Nat., 20, 1911, 161.) Motile. From Icsions on the vanilla vine

Bacterium castinicolum Cavara. (Rev. d. Pat. Veg., 7, 1914, 5) Motile. From ehestnut canker.

Bacterium corylii Brzezinski. (Bull. Intern Acad des Sei. Cracovic, Cl. Sei. Math. e Nat, 1903, 139) Motile. From diseased filbert trees.

Bacterium dendrobii Pavarino. (Rev. di Pat. Veg., 5, 1912, 242.)

Bacterium dianthi Chester. (Parasitic bacteria, Arthur and Bolley, Purdue Univ. Agr. Exp. Sta., Bull 59, 1896, 21; Chester, Ann Rept. Del. Col. Agr. Exp. Sta., 9, 1807, 100; Bactlus dianthi Chester, Man Determ. Bact., 1901, 253; Pseudomonas dianthi E. F. Smith, U. S. Dept. Agr., Div. Veg. Phys. and Path., Bull. 28, 1901, 183.) Motile. From lesions on earnation leaves.

Bacterium fici Cavara. (Ist Bot. del. R. Univ di Catania, Atti Acad. Gioen., 18, Mem. 14, 1905, 1, Phytomonas (?) fici Magrou, in Hauduroy et al., Diet d. Bact. Path. 1937, 354) Motile.

Causes a blight of figs

Bacterium Iyeopersici var. viltati Strzalkowska (Strzalkowska, Aeta Soc. Bot Poloniae, Warsaw, 7, 1930, 611; Phytomonas viltati Burkholder, in Manual, 5th ed., 1939, 216) From rotting tomato.

Bacterium malı Brzezinski. (Bull. Intern. Acad. Sci Cracovic, Cl Sci. Math e Nat , 1903, 100 ) Motile.

From apple canker

Bacterium montemartinii Pavarino (Rev. di Pat Veg , 5, 1911, 65) Motile.

From wisterna canker

Bacterium (†) omedai Peglion (Peglion, 1899, quoted from Hauduroy et al., Diet Bdet. Path, 1937, 388, Bacillus oncidi: Stevens, 1913, Phytomonas (†) oncidi: Hauduroy et al., idem.) From an orchid (Oncidium sp.).

Bacterium pini Chester (Bacillus des tumeurs du Pin d'Alep, Vuillemin, Compt. rend. Acad Sei , Paris, 107, 1888, 874 and 1184 Bacillus vuillemini Trevisan, I generi e le specie delle Batteriacee, 1889, 19; Chester, Ann. Rept. Del. Col. Agr. Evp. Sta., 9, 1897, 127; Pseudomonas pini Petri, Ann. Ist. Supt. For. Naz. Firenze, 9, 1924, 187.) From galls on pine (Pruns haleponsis).

Bacterium putredinis Davaine. (Davaine, Bactéries, in Dictionnaire Encyclopédique des Sci. Médicales, 1886, Bacillus putredinis Trevisan, Add. ad Gen., p. 36; see DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1025; not Bacillus putredinis Weinberg, Nativelle and Prévot, Les Microbes Anaérobies, Paris, 1937, 755) Causes a soft rot of several plants.

Bacterium pyri Brzezinski. (Bull. Internat. d. l'Acad. des Sei. de Cracovie, Cl. Sci. Math. e Nat., 1903, 130.) Mo-

tile. From pear canker.

Bacterium rubefaciens Burr. (Burt, Ann. App. Biol., 15, 1028, '570; Phytomonas rubefaciens Magrou, in Hauduroy et al., Diet. Bact. Path., 1037, 406; not Bacterium rubefaciens Chester, Ann-Rept. Del. Col. Agr. Exp. Sta., 9, 1807, 115.)

Bacterium suberfaciens Burr. (Burr, Ann. App. Biol., 15, 1928, 570; Phylomonas suberfacens Magrou, in Hauduroy et al., Diet. Baet. Path., 1937, 417.) Motile. Prom diseased potato tubers

48. Bacterium rubefaciens (Zimmermann) Chester. (Bacillus rubefaciens Zimmermann, Die Bakterien unserer Trink- und Nutzwässer, Chennitz, I, 1890, 26, Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 115; Erghirobacillus rubefaciens Holland, Jour. Bact., 5, 1920, 223, Serratia rubefaciens Bergy et al, Manual, 1st ed, 1923, 92; Chromobacterium rubefaciens Topley and Wilson, Princ Bact. and Immun, I, 1931, 402.) From Latin ruber, red and facie, to make-

Rods-1.9 to 16 microns in length, occurring singly and in pairs. Actively motile. Gram-negative

Gelatin colonies. Minute, white.

Gelatin stab: Surface growth yellowish, the medium taking on a red tinge. No liquefaction.

Agar colonies: Small, white, with erose margin.

Agar slant: White, smooth, glistening, somewhat luxuriant, the medium taking on a wine red color.

Broth: Turbid with white pellicle, the medium slowly assuming a reddish tinge

Litmus milk: Acid, with slow coagula-· tion and reduction of the litmus coming alkaline

Potato A heavy, white, creamy laver.

which later becomes yellowish-brown Indole not produced

Nitrites produced from nitrates

Aerobic, facultative.

Optimum temperature 25°C growth at 37°C

Habitat Water

49 Bacterium rubidum (Eisenberg) Chester. (Bacillus rubidus Eisenberg. Bakt. Diag , 3 Aufl , 1891, 88, Bacterium rubidus (sic) Chester, Ann Rept Del Col. Agr. Exp. Sta , 9, 1897, 107 and 115, Serratia rubida Levine and Soppeland. Iowa State Coll Engineering Exp Sta Bull 77, 1926, 53 ) From Latin rubidus, red.

Description from Eisenberg (loc cit ) Levine and Soppeland (loc cit) found an organism in buttermilk which they identified as Serratia rubida. Their description is more complete than that given by Eisenberg but differs from the

original in several respects Rods Medium size with rounded ends.

often in long chains Motile Gelatin colonies Circular, finely granular, entire, with reddish center Slow

growth Gelatin stab. Liquefaction Brown-

ish-red sediment. Agar colonies: Small, flat, smooth,

amorphous, entire, brownish-red growth. Agar slant: Brownish-red streak

Spreading over surface Potato: Brownish-red growth

Blood scrum liquefied, red pigment Aerobie, facultative.

Does not grow well at 37°C Source: Water.

50 Bacterium latericeum (Adametz) Lehmann and Neumann (Bacillus latericeus Adametz, Die Bakterien der Trink- und Nutzwässer, Mitteil, der oestrr Versuchsanst f. Brauerei u. Malzerei in Wien, 1888, 50; Bacillus ernthracus Trevisan. I generi e le specie delle Batteriacce, 1889, 19, Bacterium latericeum Lehmann and Neumann, Bakt Diag , 1 Aufl , 2, 1896, 258, Serratio latericea Bergey et al , Manual, 1st ed . 1923. 94 ) From Latin latericeus, blick

Rads. 0 5 to 0 7 by 1 0 to 1 3 microns Non-motile Gram-negative

Gelatin colonies Small, white, granujar, with slightly irregular margin.

Gelatin stab A thin, dry, spreading, cream pink surface growth. No lique-

faction Agar colonies. Dry. glistening, whit-

ish, with irregular margin Agar slant Brick-red, smooth, glis-

tening, butyrous Broth Thick pellicle, fluid clear

Litmus milk Alkaline

Potato Brick red streak No gas from carbohydrate media

Indole not produced Nitrates produced from nitrates.

Aerobic, facultative

Optimum temperature 25° to 30°C Habitat Water

51 Bacterlum alginicum Waksman, Carey and Allen (Jour Bact, 28, 1931, 213)

Rods short to almost spherical, 0 6 to 10 micron in diameter Sluggishly Capsule-forming Grammotile negative

Algeme acid plate White, finely granulated colonies, with entire margin Does not clear up the turbidity in plate Odor formed, resembling that of old notatoes

Alganic acid liquid medium. Thin pellicle, weak alginase formation

Ser water gelatin Thin growth throughout gelatin stab, no liquifaction in 7 days at 15°C.

Agar liquefaction: None.

Sea water glucose broth: Uniform but

very limited turbidity; no pellicle; no sediment.

Litmus milk containing salt: No ap-

parent growth.

Potato moistened with sea water: Moist, spreading growth, cream-colored; heavy sediment in free liquid at bottom. Starch plate: Limited, pale blue

growth: no diastase.

Aerobic.

Ontimum temperature 20°C.

Source: From sea water, and from the surface of algal growth.

Habitat: Common in sca water.

52. Bacterlum terrestralginicum Waksman et al. (Waksman, Carev and Allen, Jour. Bact., 28, 1934, 217.)

Long rods, with somewhat rounded ends, usually single, but also in pairs. and occasionally in chains of shorter rods. 1.0 to 1.5 hy 1.5 to 2.5 microns. Motile. Granular. Gram-negative.

Alginic acid plate: Colonies small. whitish in appearance with a slight

metallic sheen.

Alginic acid liquid medium: Medium at first clouded. Later, a pellicle is formed on the surface of the medium, which is soon broken up due to active gas formation. Reaction of medium becomes slightly alkaline.

Gelatin medium: Slow growth throughout stab, slow liquefaction at surface of medium at 18°C.

Agar liquefaction: None.

Glucose broth. Abundant turbidity. some scdiment, no pellicle, slightly fluorescent.

Litmus milk. Acid, milk coagulated, only limited digestion of coagulum.

Potato: Abundant, pinkish, compact, dry growth on surface of plug, the rest of plug becoming gray, with a tendency

to darkening. Starch plate: Limited growth along

streak, no diastase. Aerobic to facultative anaerobic.

Optimum temperature 30°C. Source: From New Jersey soil.

Habitat : Soil.

53. Bacterium cygni Migula. (Septikāmiebaeillus der Schwane, Fiorentini, Cent. f. Bakt., 19, 1896, 935; Migula, Syst. d. Bakt., 2, 1900, 365; Bacillus cygneus Chester, Manual Determ. Bact., 1901, 221.) From Latin cygnus, swan.

Rods: Motile. Gram negative. This organism may have been the fowl cholera or septicemia organism (Pasteurella avicida Trevisan); but is more probably closely related to the organism which causes keel in ducklings (Salmonella anatis Rettger and Scoville).

Source: From a swan.

Habitat: The cause of an infectious disease of swans in the city park at Milan, Italy in 1895.

54. Bacterlum cyprinicida Picha (Plehn, Cent. f. Bakt., I Abt , Orig , \$5, 1903-04, 461; Klebsiella cyprinicida Bergey et al., Manual, 2nd ed., 1925, 266.) From Greek kyprmos, carp sad Latin caedo, to kill.

Rods: 08 by 1.0 micron, occurring singly and in chains, Capsulated. Non-motile. Gram-negative.

Gelatin colonies: White, glistening, convex, with alight fluorescence around the colony in three or four days.

Gelatin stab: White, convex surface growth. No liquefaction.

Agar slant: White, glistening layer, becoming slimy.

Broth: Turbid, with thick gray pellicle

and slimy sediment. Litmus milk: Slightly alkaline, No

coagulation. Potato: Light- yellowish layer, be-

coming dark brownish. The medium is dark violet-gray.

Indole not formed.

Nitrites not produced from nitrates. No acid from carbohydrate media. Acrobic, facultative.

Optimum temperature 10° to 20°C.

Habitat: The cause of a fatal disease in carp, showing as red spots on the ventral surface.

55. Bacterium parvulum Conn. (N. Y.

Agr. Exp. Sta. Bul. 491, 1922, 26.) From Latin, very small

Very small rods: 01 to 02 by 03 to 05 micron. Non-motile Gram-negative.

Gelatin plate: Punctiform colonies Agar plate: Punctiform colonies

Grows poorly in liquid media
Indole not formed.

Nitrites produced from nitrates

Nitrites produced from

No acid from glucose, lactose, sucrose, glycerol or ethyl alcohol in either liquid or solid media

Starch not digested.

Optimum temperature 25°G Strictly aerobic.

Distinctive character. Causes strong

volatilization of ammonia from a mixture of horse feces and urine

Source: From manure Habitat, Soll.

 Bacterlum methylicum (Loew) Migula (Bacillus methylicus Loew, Centf. Bakt., 12, 1892, 465; Migula, Syst d Bakt., 2, 1900, 447) From the chemical term, methyl.

Short, thick rods 10 by 20 to 25 microns Gram stain not recorded

Gelatin colonies: After 2 days, round to oval, yellowish, entire; later edges ciliate. Liquefaction.

Glucose gelatin stab. Liquefaction crateriform. Whitish-yellowish sediment No liquefaction in depth

Glucose gelatin stab. In depth, little or no growth, slowly liquefied near surface.

Agar stab Surface growth spreading, grayish-white. No growth in depth. Broth. No turbidity. On the surface and adherent to the walls, a white ring which precuntates on shaking.

Potato Growth very slow, pure white, adherent

Grows well in 05 per cent methyl alcohol, 005 per cent dicalcium phosphate, and 00f per cent magnesium sulfate, on which broth it forms a reddish pellicle

Possesses the ability to decompose formaldehyde and formic acid salts with formation of a reddish pellicle

Aerobe. Source. A culture contamination from

the air Ifabitat Probably soil

Appendix I: A few of the numerous Gram negative, motile or non-motile, nonspore-forming rods that do not belong in the groups previously listed in this genus are described here. All have been placed in the genus Bacillus by those who have described them, although none form spores

- Produce a pink to red chromogenesis
   A. Motile.
  - A. Motile.

- 1. Bacillus lactorubefaciens
- B Non-motile.
  - Gelatin liquefied
     .
     Gelatin not liquefied
- 2. Bacillus rubricus 3. Bacillus rufus
- 3. Dacuus
- a. Salmon pink on agar.
  - 4. Bacillus mycoides corallinus
- na. Vinous red on agar.

  5. Bacıllus bruntzii.
- If. Produces a water-soluble orange to emerald green pigment. A. Motile.
  - Gelatin liquefied.
- 6. Bacillus aurantiacus tingitanus

 Baeillus lactorubefaciens Gruber. (Gruber, Cent. f. Bakt., II Abt., 8, 1902, 457; Serratia lactorubefacions Bergey et al., Manual, 1st ed., 1923, 92) From Latin, to make milk red.

Small rods: 04 to 06 by 35 microns. occurring singly and in pairs. Motile with peritrichous flagella. Gram reaction not given.

Gelatin colonies. Gravish-white. smooth, glistening, spreading.

Gelatin stab: At times arborescent: the medium tinged with red. No liquefaction.

Agar colonies: Circular, lobed, grayish, contoured

Agar slant White, spreading growth. Broth. Turbid, with grayish pellicle and slimy sediment.

Limus milk: Becomes rose red, slimy, slightly acid, without coagulation.

Potato: White, spreading growth. No gas from carbohydrate media.

Indole not produced.

Nitrites produced from nitrates. Acrobic, facultative Optimum temperature 25°C.

Habitat Milk.

2 Bacillus rubricus Hefferan (liefferan, Cent. f Bakt , II Abt., 11, 1903, 403; Erythrobacillus rubricus Holland, Jour, Bact , 5, 1920, 220; Serratia rubrica Bergey et al , Manual, 1st ed , 1923, 313; Chromobacterium rubricum Topley and Wilson, Princ. Bact. and Immun., 1, 1931, 402)

Rods 07 to 09 by 10 to 4.0 microns, occurring singly Non-motile. Gram

reaction not given Gelatin colonies, Small, circular, yel-

low-orange, deepening to red. Gelatin stab Slow liquefaction. Old

cultures lose this property.

Agar colonies Circular, raised, entire Agar slant Mosst, spreading, white to pink, gradually deepening in color.

Broth Turbid, with viscid sediment Litmus milk Alkaline

Potato Slight growth, bright pink, turning coral red

Indole not produced.

Nitrites not produced from nitrates

No seid or gas from carbohydrate media.

Aerobic, facultative.

Optimum temperature 25° to 30°C. No growth at 37°C.

Source: Isolated from Mississippi river water, also from buttermilk.

3. Bacillus rufus Hefferan. (Hefferan, Cent. f. Bakt., II Abt., 11, 1903, 313; Erythrobacillus rufus Holland, Jour, Bact., 5, 1920, 220; Serratia rufa Bergey et al., Manual, 1st ed., 1923, 95 ) From Latin rufus, red.

Differs from Bacillus rubricus in show. ing more luxurient growth on potato and slower action in milk.

Source: From Mississippi River water.

4. Bacillus mycoides corallinus Hefferan, (Hefferan, Cent. f Bakt., H Abt., 11, 1903, 459; Serratia corallina

Bergey et al., Manual, 1st ed., 1923, 93) Small, slender rods, 1.2 to 2.0 microns in length, occurring singly and in pairs.

Non-motile. Gram reaction not given. Gelatin colonies: Minute, becoming

pink, smooth, raised. Gelatin stab: Slow growth. Raised,

smooth, glistening, pink surface growth. Fine, feathery growth in stab No lique. faction.

Agar colonies: Minute, with filamentous margin.

Agar slant: Smooth, moist, salmon pink.

Broth. Turbid, with pink flakes on surface.

Litmus milk: Alkaline, with red surface.

Potato: Like agar slant.

Indole not formed.

Nitrites produced from nitrates. No gas from carbohydrate media.

Aerobic, facultative.

Optimum temperature 25° to 30°C. Source: Isolated from Mississippi river water.

5. Bacillus bruntzli Nepveux. (Nepveus, Compt rend. Soc. Biol., Paris, 72, 1920, 242; Thèse, l'ac. de Pharm., Jouve et Cie, Paris, 1920, 136 pp.; Serratia bruntzii Bergey et al., Manual, 3rd ed., 1930, 125.) Named for Prof. Bruntz of Paris

Bacillus roseus fluorescens Marchal (Trav. Lab Microbiol Fac Pharm Nancy, 1937, 90) is regarded by Lasseur (personal communication, 1938) as identical with Bacellus bruntzes Nepveux.

Rods: 0 3 to 0 5 by 1 25 to 1 5 microns. occurring singly and in pairs motile. Gram-negative. The cells store volutin and glycogen as reserve meterials

Gelatin colonics, Circular, gray, smooth, contoured, glistening, undulate margin, becoming red.

Gelatin stab. No liquefaction

Agar colonies Circular, flat, smooth, contoured, radiate margin, vinous red Agar slant, Smooth, echinulate, butyrous, vinous red in color

Broth Turbid.

Litmus milk Unchanged

Indole not formed.

Nitrates produced from natrates Acid from glucose, fructose, maltose, lactose, sucrose, mannitol, dulcitol and

glycerol. Aerobic, facultative

Optimum temperature 20° to 25°C Habitat: Water

6. Bacillus aurantlacus tingitanus Remlinger and Bailly (Compt rend Soc Biol, Paris, 119, 1935, 246 )

Short rods Usually 2 to 3 merons, sometimes 5 to 6 microns long Actively

motile Gram-negative

Growth occurs on all the ordinary media. Fluorescent bright nutrient

orange pigment

Gelatin: Rapid liquefaction Milk Slow coagulation

Synthetic broth. Lasseur, Duparx-Lasseur and Marion (Trav Lab Micro. biol Fac Pharm Nancy, Fasc 9, 1936, 34) recognize two rough types of this organism, one of which forms a smooth and the other a wrinkled pellicle. The smooth type gives a rough (pH 47) or a smooth (pH 6 3) pellicle according to the pli of the medium

Indole not formed.

Artichoke media Luxuriant growth. Emerald green pigment produced On transferring the culture to potato, the bright orange pigment reappears

Coagulated serum · No liquefaction.

Acid from sucrose, lactose, glucose, mannitol and maltose

Non-pathogenic

Optimum pH 66 No growth at pH 62, but grows at pH 78

Optimum temperature 20°C Good grouth from 15° to 37°C

Aerobic

Pigment Orange or capucine pigment which diffuses throughout the medium. Not affected by the presence or absence of light Pigment production depends on the growth of the culture, not on the andity of the medium Insoluble in acetone, amyl alcohol and gasoline Partially soluble in ether and ethyl alcohol which are colored yellow

Distinctive character A fluorescent pigment of an unusual shade (bright orange)

Source From water at Tangiers Habitat Presumably water.

Appendix II: The anaerobic genus Methanobacterium was proposed tentatively by Kluyver and Van Niel in 1936 with indication that they regarded Söhngen's methanc bacterium as the type species of the genus Later, Barker (1936) found orgamsms that he regarded as identical with those previously isolated by Sohngen and he proposed the name Methanebacterium sohngenis for this species A second species found at the same time was named Methanobacterium omelianskii and it was identified as the species previously described but not named by Omehansky At the time, he felt that these anaerobes should be included in the family Mycobacteriaceae (1936.

<sup>\*</sup> The manuscript for this section has been reviewed by Dr. II. Albert Barker. University of California, Berkeley, California, February, 1945.

p. 422). In 1940, be discovered that the second species produced spores. In a personal communication (March 20, 1945) be suggests that further work is needed hefore the relationships of these organisms can be charified.

## Genus A. Metbanobacterium Kluyver and Van Niel. (Cent. f. Bakt., II Abt., 94, 1936, 399.)

Straight or slightly hent rods, sometimes united in bundles or long chains. Usually non-motile. Endospores sometimes formed. Anaerobic. Chemo-heterotro-phic or chemo-autotrophic oxidizing various organic or inorganic compounds and reducing carbon diovide to methane. Gram-variable, usually negative.

The type species is Methanobacterium soehngenii Barker.

 Methanobacterium soebngenil Barker. (Methanebacterium, Sohngen, Dissortation, Delft, 1905; Barker, Arch. f. Mikrobiol., 7, 1936, 433.) Named for Prof. N. L. Sölingen who first studied this organism.

Rods: Strnight to slightly bent, moderately long. Non-motile. Non-sporeforming. Gram-negative.

In liquid cultures cells are characteristically joined into long chains which often he parallel to one nnother so as to form bundles

Acetato and n-butyrate but not propionate are fermented with the production of methane and carbon dioxide.

Ethyl and n-butyl alcohols not fermented.

Obligate anaerobe.

Source: Enrichment cultures containing nectate or butyrate as the only organic compound Four strains were isolated from acctate enrichment cultures. The cultures were highly purified but not strictly pure.

Hahitat: Canal mud, sewage. Probably occurs widely in fresh water sediments where anacrobic conditions prevail.

2. Methanobacterium omelianskii Barker. (Bacille de la décomposition méthanique de l'alcohol ethylique,
Omelansky, Ann. Inst. Past., 39, 1916,
80; Barker, Arch f. Mikrobiol., 7, 1936,
436; also see Barker, Antonie van Leeuwenhoek, 6, 1940, 201 and Jour. Biol.
Chem., 137, 1941, 153.) Named for
Prof. W. Omeliansky who first observed
the organism.

Rods: 0.6 to 0.7 by 1.5 to 10 microns, usual length 3 to 6 microns, unhranched, straight or slightly bent. Usually nonmotile, occasionally feeble motility is observed. Spores of low heat resistance formed, spherical, terminal, swelling the rods.

Primary alcohols, including ethyl, propyl, n.butyl and n.amyl alcohols, are ovidized to the corresponding fatty neids. Secondary alcohols, iocluding isopropyl and sec-butyl, are oxidized to the corresponding ketones. Hydrogen is oxidized.

Fatty and hydroxy acids, glucose, polyalcohols and smino acids are not attacked.

Carbon diovide is used and converted to methano Growth and alcohol oxidation are directly proportional to the earbon diovide supply at low concentrations.

Nitrate, sulfate and ovygen cannot he used as oxidizing agents.

Utilizes ethyl alcohol best of all or-

Utilizes numonia as a nitrogen source Growing range: pH 6.5 to 8.1.

Optimum temperature 37° to 40°C.

Maximum 46° to 48°C.

Ohlicate anaerobe.

Source: Soil, fresh water and marine muds, rabbit feces, sewage. Pure cultures were isolated from fresh water and marine muds (Barker, loc. cit., 1940).

Habitat: Wherever organic matter is decomposing in an anaerobic, approximately neutral environment.

Appendix III: Miscellaneous species of non-motile, or motile, non-spore-forming rod-shaped bacteria not previously listed or described

Ascobacterium luteum Bahes in Cornil and Bahes, Les Bactéries, 3rd ed., 1, 1890, 155, also see Petri, Cent f Bakt., Il Abt., 26, 1910, 359 ) From water in Budapest (Babes) and the olive fly (Petri).

Bacillus a, b, c, d, c, f, h and 1, Vignal (Arch. d. phys norm. et path, Sér 3, 8, 1886, 350-373; also see Flavobacterium buccalis Bergey et al. and Bacillus buccalis fortuitus Sternberg | From aaliva and the teeth.

Bacillus acido-aromaticus Van der Leck. (Cent. f. Bakt , II Abt , 17, 1907,

652) From milk. Bacillus acutangulus Migula (No 13,

Lembke, Arch. f. Hyg, 29, 1897. 319, Migula, Syst. d Bakt., 2, 1900, 680) From feces Bacillus acutus Kern (Arb hakt

Inst. Karlsruhe, 1, Heft 4, 1896, 433) From the stomach of a bird

Bacillus adametzis Mıgula. (Bacıllus XIII, Adametz, Landwirtsch Jahrb., 18, 1889, 246, Migula, Syst d Bakt , 2, 1900, 686, not Bacillus adametzi Trevisan, I generi e le specie delle Batteriacce, 1889, 19 ) From cheese

Bacillus acris Chester (Bacillus 110laceus sacchart Ager, N. Y. Med. Jour 1891, 265; see Dyar, Ann N. Y Acad Sci , 8, 1895, 369; Bacterium riolaceous sacchari Chester, Ann Rept Del Col. Agr Exp. Sta., 9, 1897, 116, Chester, Man. Determ. Bact., 1901, 260 ) From Produces a violaceus black pigment in old cultures in milk.

Bacillus aerobius Doyen. (Bacillus urinae aerobius Doyen, Jour il connaiss. m(die., 1883, 107; Doyen, ibid., 108) From urine.

Bacillus aerogenes Miller, (Miller, Deutsche med. Wehnschr., 12, 1886, 119, see Miller, Die Mikroorganismen der Mundhöhle, Leipzig, 1889, 262, not Ba-

cillus aerogenes Kruse, in Flügge. Die Mikroorganismen, 3 Aufl., 2, 1896, 340.) From the stomach.

Bacıllus aeragenes sputigenus capsulatus Herla (Arch. de Biol , 14, 1895, 403; abst in Cent f. Bakt., 25, 1899, 359.) From the blood of a mouse which had been inoculated with the soutum of a pneumonia patient,

Bacillus aeschynomenus Trevisan. (Bacılle de l'air 1, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 150; Trevisan. I generi e le specie delle Batteriacce, 1889, 20.) From air.

Bacillus aëthebius Trevisan. (Bacille de l'air c. Babes, in Cornil and Babes. Les Bactéries, 2nd ed , 1886, 149; Trevisan, I generi e le specie delle Batteriacce,

1889, 20) From air.

Bacıllus agılıs Trevisan (Bacillus der Vagus-Pneumonie, Schou, Fortschr. d Medicin, 3, 1885, No 15; Bacillus pneumonicus agilis Flügge, Die Mikroorganismen, 2 Auff., 1886, 262, Trevisan, I generi e le specie delle Batteriacce. 1889, 14; not Bacillus agilis Techistowitselt, Berl klin Wochnschr., 1892, 512; not Bacillus agilis Chester, Man. Determ Bact , 1991, 226, not Bacillus agilis Mattes, Sitzungsber d Gesells, z. Beforderung d gesam Naturw z. Marhurg, 62, 1927, 400, not Bacillus agilis Hauduroy et al , Diet d Bact Path .. Paris, 1937, 33, Bacterium pneumonicus agains Chester, Ann Rept Del Col. Agr Exp. Sta , 9, 1897, 110, Bacterium tagus pneumonic Chester, ibid , 144; Bacillus preumonicus Migula, Syst d. Bakt , 2, 1900, 752 ) From the hings of rabbits having vagus pneumonia

Bacilius agris Mattes (Sitzungsber, d. Gesells z Beforderung d. gesant, Natura z Marburg, 62, 1927, 406.) From the Mediterranean flour moth (Ephestia Luchniella)

Bacillus agillimus DeToni and Trevisan (Bacillus luteus putidus Maggiora, Giorn. d. Soc. ital. d'Igiene, 11, 1889, 311;

DeToni and Trevisan, in Saccardo. Sylloge Pungorum, 8, 1889, 969.) From the akin.

Bacillus agnorum Trevisan. (Bacterium subtile agnorum Rivolta, Giorn. di Anat, fisiol, degli anumali, 1881, 31 and 1883, 78; Trevisan, I generi a le specie delle Batteriacce, 1889, 13) From discased lambs.

Bacillus alacer Echstein (Ztsehr, f. Forst- u. Jagdwesen, 26, 1891, 13.) Found associated with the eggs of the nun moth (Lymantria monacha).

Bacillus alatus Grieg Smith. (Proc. Linn. Soc New So. Wales, 30, 1905, 570.) Bacillus albatus Kern. (Arb. bakt. Inst Karlsruhe, 1, Heft 4, 1896, 408.)

From the stomach and intestines of a

Bacillus albus Pagliani, Maggiora and Fratin. (Weisser Bacillus, Eisenberg, Bakt. Diag., 1 Auft, 1889, Table 7; Pagliani et al., Giorn d. Soc. ital. d'Iguno, 0, 1887, 587; not Bacillus albus Trevisan, I generi e le specie delle Batteriacce, 1889, 14, not Bacillus albus Bergey et al., Manual, 3rd ed., 1930, 398; Baclerium albus Chester, Ann Rept. Del Col Agr. Exp. Sta., 9, 1897, 76) From water

Bacillus albus anaerobiescens Vaughan. (Amer Jour Med. Sci., 104, 1892, 191.)

From water.

Bacillus albus

Baciltus athus putidus DeBary. (Quoted from Sternberg, Man of Baet, 1893, 675) From water.

Bacillus albus-putidus Chester (Maschek, see Adametz, Bakt. Nutz u. Trinkwasser, 1888, Chester, Man De-

term. Bact., 1001, 237 ) From water Bacillus albus putritus Vaughan (Amer Jour Med Scs., 104, 1892, 186)

From water

Bacillus alpha Dyar. (Ann. N. Y Acad Sci., 8, 1895, 366.) From air

Bacillus amabilis Dyar. (Dyar, Ann. N Y Acad Sci., 8, 1895, 358, Bacterium amabilis Chester, Ann. Rept Del. Cel. Agr Exp Sta., 9, 1897, 110) From air

Bacillus amarillae Trevisan (Bacille de la fiévre jaune, Babes, in Corml and Babes, Les Bactéries, 2nd ed . 1886, 529; Trevisan, I generi e le specie delle Batteriacce, 1889, 13.) From a case of yellou fever.

Bacillus amarus Migula. (Bacillus liquefariens lactis amari v. Freudenreich, Landwirtseh. Jahrb. d. Schweiz, 8, 1891; Migula, Syst. d. Bakt., 2, 1900, 601; not Bacillus amarus Hammer, Iowa Agr. Exp. Sta. Res. Bull. 52, 1919, 198.) From bitter milk.

Bacillus amerimnus Trevisan. (Bacille de l'air b, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1885, 149; Trevisan, I generi e le specie delle Batteriacee, 1889, 20) From air.

Bacillus amygdaloides Weiss. (Arb bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 216) From brine on salted pickles.

Bacillus anceps Trevisan. (Bacille du mucus intestinal normat a, Babes, in Cornil and Babes, Les Bactéries, 2nd ed, 1886, 153; Trevisan, I generi e le specie delle Batteriacce, 1889, 15.) From normal intestinal mucous.

Bacillus anthraciformis Wilhelmy (Arb. bakt. Inst. Karlsruhe, 5, 1903, 28)

From meat extract.

Bacillus anthracoides Trevisan. (Bacille de l'air k, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 181; Trevisan, I generi e le specie delle Batteriacce, 1889, 20; not Bacillus anthracoides Kruse, in Fluge, Die Miktoorganismen, 3 Aufl., 2, 1896, 232.) From

air.

Bacillus annulalus Zimmermann.

(Bakt unserer Trink u Nutzwasser,

Chemnitz, 2, 1894, 30.) From water.

Bacillus anularius Henrici. (Arb.
hakt Inst Karlsrulie, 1, Heft 1, 1894,

32.) From Emmenthal cheese.

Racillus apicum Kruse. (Canestriui, Atti Soc Ven. Trent. Sci. Nat., 12, 1892, 134; Kruse, in Flugge, Die Mikroorganismen, 3 Aufl, 2, 1896, 233) From infected bees and their larvae.

Bacillus apisepticus Burnside. (Jour. Beon. Ent., 21, 1928, 379.) Pathogenic for the honey bee (Apis mellifera)

Bacillus aquatilis Migula (Bacillus

aquatilis sulcatus IV, Weichselbaum, Das östereichische Sanitätswesen, 1859, No. 14-23; Bacterium aquatilus sulcatus quartus Chester, Ann Rept. Del Col Agr. Exp Sta, 9, 1897, 72; Migula, Syst. d. Bakt. 2, 1900, 733, not Bacillus aquatilus Frankland and Frankland, Ztechr 1, Hyg., 6, 1859, 381; Bacillus aquatitus Frankland end Frankland, Ztechr Bact., 1901, 216). From water

Bacillus aquatitis Trevisan (Bacille de l'eau a, Babes, in Cormi and Babes, Les Bactèries, 2nd ed., 1886, 167, Trevisan, I generi e le specie delle Batteriacce, 1880, 19, not Bacillus aquatitis Frankland, Zischr f Ilyg, 6,

1889, 381 ) From water

Bacillus aqualitis communis Kruse (Kruse, in Fluge, Die Mikroorganismen, 3 Aufl., 2, 1896, 315, Bacterum aqualitis communis Chester, Ann Rept Del Col Agr. Exp. Sta., 9, 1897, 91) Found commonly in water Lasted by Kruse as a non-chromogenie strain of Bacillus fluorescens liquifaceris (Pseudomonas fluorescens liquifaceris (Pseudomonas fluorescens liquifaceris)

Bacillus arborescens Jamieson and Edington. (Brit. Med Jour, 1, 1887, 1265.) From the desquamation of scar-

let fever patients

Bacillus arboreus Migula (Baumchenbaeillus, Maschek, Bakt Untersuch, d Leitmeritzer Trinkwasser, Leitmeritz, 1887, Migula, Syst d Bakt, 2,

1900, 710 ) From water

Bacillus aroundicus Beigernek (Quoted from Yan der Leck, Cent f Bakt, 11 Alt., 17, 1907, 490, not Bacillus aronaticus Panmel, Bull 20, 100a Agr Lyp Sta, 1835, 792, not Bacillus aro vaticus Grimm, Cent f Bakt, 11 Abt, 8, 1902, 589; not Bacillus aromaticus Van der Leck, loc cit, 659) From milk,

Bacillus aromaticus Van der Leck (Van der Leck, Cent f Bakt, 11 Abt, 17, 1907, 659.) 1 rom soft cheeses

Bacillus assimilis Trevisan (Bacille de Pair i, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 150, Trevisan, 1

generi e le specie delle Batteriacce, 1899, 29) From air.

Bacillus aurantius Trevisan (Orangerother Wasserbaeillus, Adametz and Wichmann, Mitth. Oest Vers Stat f Brauerei u Malz, in Wien, 1, 1888, 50; Trevisan, I generi e le specie delle Batteriacce, 1889, 19, not Bacillus aurantius Bergey et al., Manual, 3rd ed., 1930, 421) From water

Bacillus aureus Eckstein (Zischr. f. Forst. u Jagdwesen, 20, 1821, 9) probably not Bacillus aureus l'rankland and Frankland, Phulos Trans Roy. Soc London, 178, B, 1887, 272 and probably not Bacillus aureus Pansini, Arch f. path Anat. u Physiol, 122, 1809, 436; not Bacillus aureus Adametz, quoted from Sternberg, Man in Bact., 1893, 621) Capable of infecting the larvae of various insects

Bacillus azurcus Zinnnermann.
(Bakt unserer Trink u Nutzwisser,
Chemnitz, 2, 1894, 21) From water,
Bacillus babes: Trevisan (Baeille du
mucus intestinal normal b, Babes, in

Cormi and Babes, Les Bactéries, 2nd ed., 1886, 183, Trevisan, I genen e le specie delle Batteriacee, 1889, 15.) Frim nor-

mal intestinal mucus

Bacillus beljanti, Migula (Hane neue patingene Bakterumart im Tetanispatingene Bakterumart im Tetanistanis Kinda, 4, 1888, 513, Bacillus accidentalis tetanis Krive, un Tlüage, Des Mikroorganismen, 3 Aufl. 2, 1876, 433, Benterruma accidentalis tetani Chester, Ann Rept Del Col Agr Ivp Sta, 2, 1876, 88, Migula, Syst di Bakt. 2, 1900, 767; not Bacillus beljanti Carbone and Venturelli, Boll 1st Siernier, Minn. 4, 1925, 59, Bacillus accidentalis Chester, Man Determ Bact, 1901, 229) From 1981 in a cress of tetanus.

Bacillus benzoli Tansson (Planta, 7, 1929, 735) From soil Oxidizes benzene

Bacillus berilericus Trevisan. (Carratt di ale nuov gen di Batt, 1885, 12) From cases of beri beri in Japan Also see Ogata, abst. in Cent. f. Bakt., 5, 1888, 75.

Bacillus berolinensis Migula. (Roter Bacillus aus Wasser, Fraenkel, Grundriss der Bakterienkunde, 3 Aufl, 1890, 252; Bacillus ruber berolinensis Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 303; Bacterium ruber berolinensis Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 113; Miguls, Syst. d. Bakt., 2, 1900, 856; not Racillus berolinensis Chester, Man. Determ. Bact., 1901, 305.) From water. Rust-red to orange-yellow pigment on potato.

Bacillus beta Dyar. (Ann. N. 1 Acad Sci., 8, 1895, 366.) From air.

Bacillus beyerinch: DeToni and Trevisan (Bacillus radicicola var. liquefaciens Beijerinck, Bot. Zeitung, 1883, 750; DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 072; not Bacillus beijerinchi: Henneberg, Ztschr. f. Spiritusindustrie, 26, 1903, 22; see Cent. f. Bakt., II Abt., 11, 1903, 150.) From soil and the roots of legumes.

Bacillus billingsi Chester. (Bacillus of corn-stalk disease of cattle, Billings, in Baumgarten, Jahresbericht, 1859, 181; Chester, Man. Determ. Bact., 1001, 214) Isolated by Billings from corn-stalk disease of cattle, and by Nocard from bronchopneumonia in oxen

Bacillus bombycis Chatton (Chatton, Compt. rend. Acai Sci, Paris, 156, 1913, 1768; not Bacillus bombycis Macchati, Stazioni sperimentali Agrarie Italiane, 20, 1891, 121; Bacterium bombycis Paillot, L'infection chez les insectes, 1933, 131.) From diseased silkworms (Bombyz moni)

Bacillus booker! Dyur. (Dyur, Ann N. Y Acad. Sci., 8, 1895, 378, not Bacillus booler: Ford, Studies from the Royal Victoria Hospital, Montreal, f, 1903, 31.) Found by Dr. Prudden in a case of cystitis.

sa Gorn Sc J DeTom an Sylloge Fungorum, 8, 1889, 967.) From the skin.

Bacillus brunneus (Schrocter) Schroeter. (Bacteridium brunneum Schroeter. in Cohn, Beitr. z. Biol. d. Pflanz., 1, Heft 2, 1872, 126; Schroeter, in Cohn, Kryptog. Flors v. Schlesien, 3 (1), 1886, 158; not Bacillus brunneus Adametz and Wichmann, Die Bakt, der Nutz- und Trinkwässer, Wien, 1888; Bacıllus fuscus Flugge, Die Mikroorganismen, 2 Aufl., 1886, 290; not Bacillus fuscus Zimmermann, Bakt. unserer Trink- u. Nutzwasser, Chemnitz, 1, 1800, 70,) Bacterrum brunneum Schroeter or Cohn is given as a synonym by Flugge (1886) and by Trevisan (1889) but this appears to be an incorrect spelling of Bacteridium brunneum Schroeter. Neither Schroeter nor Cohn used Bacterium brunneum in 1872 or later so far as can be determined by a careful study of their papers. From corn, wheat and potato infusions.

Bacillus buccolis fortuitus Sternberg (Bacillus I, Vignal, Arch, Phys. norm. et path., Sér. 3, 8, 1886, 337; Sternberg, Man. of Bact., 1893, 685; Bacterium bucolis (sic) fortuitus Chester, Ann Rept. Del. Col. Agr. Evp. Sta. 9, 1897, 91 and 130, Baccillus bucalis (sic) Chester, Man. Determ Bact., 1901, 234; not Bacillus buccalis Trevisan, I generi o le specie delle Batternacee, 1889, 15) From the mouth.

Bacillus buccalis muciferens Miller. (Miller, Dental Cosmos, 53, 1891, 792 and 800.) From the blood. A slims capsulated bacillus

Bacellus buccalis septicus Miller. (Miller, Dental Cosmos, 55, 1891, 792 and

tyri I, v. Klecki, Cent. I. Bakt., 16, 1894, 357; Migula, Syst. d. Bakt., 2, 1900, v and 811) From rancid butter.

Bacillus caeci Ford. (Studies from the Royal Victoria Hosp., Montreal, 1, (5), 1903, 45, also see Jour Med Res,

1, 1901, 217.) From the stomach and rectum.

Bacillus canalensis Castellanı (Proc Soc. Exp Biol, and Med., 25, 1928, 540 ) From human feces.

Bacillus canus Migula. (Grauer Bacillus, Maschek, Untersuch d Leitneritzer Trinknässer, Leitmeritz, 1887, Migula, Syst. d. Bakt., 2, 1900, 711 ) From water.

Bacillus canus Eckstein (Ztschr f Forst- u Jagdnesen, 24, 1891, 15) From larvae of the nun moth (Lymaniria monacha.)

Bacillus carabiformis Raczyscki (Diss. milit medie Acad Petropolitanae Rutoniae, 1888; abst in Cent f Bakt. 6, 1889, 113.) From the stomach of a dog

Bacillus carnis Wilhelmy (Wilhelmy, Arb bakt, Inst. Karlsruhe, 3, 1903, 21, not Bacillus carnis Klein, Cent f Bakt . II Abt , 55, 1903, 459) From meat extract.

Bacillus Loclimann easeoluticus (Cent f. Bakt , I Abt , Orig , \$1, 1902, 385.) From the organs of guinea pigs which had been inoculated with tubercle bacelli.

Bacillus cathetus Trevisan (Bacille de l'air q. Babes, in Cornd and Babes, Les Baetéries, 2nd ed., 1886, 150, Trevi san, I generi e le specie delle Batteriscee,

1889, 20 1 From air.

Bacillus caviae Trevisan, (Bacille du mucus intestinal normal du cobaye e, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 154; Trevisan, 1 generi e le specie delle Batteriacce, 1889, 15; Pasteurella carrae DeTons and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1884, 996; not Pasteurella carrae Hauduroy et al., Dict d. Bact Path , 1937, 313.) From the intestinal mueus of guines pigs.

Bacillus centralis Zimniermann (Bakt. unserer Trink. u Nutzugeser, Chemnitz, 2, 1591, 10 ) From water

Bacillus charring Trevisan (Bacille

de la pseudo-tuberculose bacillaire du cobase, Charrin and Roger, Compt rend Acad. Sci . Paris, 100, 1888, 868. Trevisan, I generi e le specie delle Bat. terracee, 1889, 13.) From pulmonary tuberculosis of guinea pigs

Bacillus chlorinus Migula (Grungelber Bacillus, Tataroff, Inaue Diss., Dorpat, 1891, 50, Migula, Syst d Bakt . 2. 1900. 820, not Bacillus chlorinus I rank. land and Frankland, Philos Trans, Roy. Soc London, 178, B. 1887, 271 ) From water.

Bacillus chuluriae Trevisan (Bacillus of chyluria, Wilson, Brit. Med. Jour .. No 1249, 1884, 1128, Trevisan, Atti Acad Aled Fis Stat Milan . Ser. V. 5, 1885, 99 ) From ehyluria.

Bacillus citreus (Unna and Tommasoli) Kruse (Accobacellus cetreus Unna and Tompiasoli, Monats I prakt Dermatol., 9, 1890, 60, Kruse, in Plugge, Die Mikroorganismen, 3 Aufl, 2, 1806, 309, not Bacultus citrcus Frankland and I'rank, land, Philos Trans Roy Soc , London, 178, 1887, B. 272, Pacterium estreus Chester, Ann Rept Del Col Agr. Exp. Sta. 9, 1897, 101) From the human ekin in cases of occema

Bocillus citricus Kern. (Kern, Arb bakt Inst Karlsruhe, 1, Heft 4, 1890, 426, not Bacillus estricus Weiss, ilid , 2, Heft 2, 1902, 231) From the intestines of hirds

Bacillus citrinus Migula (Citrongelber Bacillas, Maschek, Bikt Untersuch d Leitmeritzer Trinkwasser, 1887, Migula, Syst. d. Bakt., 2, 1900, 832.). From water

Bacillus eladogenes Trevisan (Bactérie de l'air No 3, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 140. Tresiero, I genera e le specie dello Batteriacee, 1889, 20 ) From air.

Bacillus elgesformis Doven (Bacillus uringe clariformis Doyen, Jour. d. connsiss medie, 1889, 106, Doyen, ibid., 108. Boeillus dozent DeToni an I Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 949.) From urine.

Bacillus clconi Picard. (Bull. Soc. d'Étude et de Vulgarisation Zool. Agric., 12, 1913, 134.) A fluorescent coccobacillus. From diseased larvae of weevils (Temnorthinus (Cleonus) mendicus).

Bacillus coccineus Catiano (Catiano. in Cohn, Beitr. z. Biol. d. Pflanz., 7. 1896, 339; not Bacillus coccineus Pansini. Arch. f. path. Anat , 122, 1890, 437; Bacillus subcoccineus Migula, Syst. d. Bakt , 2, 1900, 857.) From the vagina. Reddish pigment.

Bacıllus coerulea-viridis Trevisan. (Blaugrûn fluorescirende Bacterium. Adametz, Mitth. Oest. Vers Stat. f. Brauerei u. Malz. in Wien, 1, 1888, 46; Trevisan, I generi e le specie delle Batteriacee, 1889, 20; Bacterium cocrulcoviride DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1087.) From water.

Bacillus cocruleus Eckstein. (Eckstein, Ztschr f. Forst- u. Jagdwesen, 26, 1894, 14; not Bacillus coeruleus Smith, Med News, 1887, 758; probably not Bacillus cocruleus Voges, Cent. f. Bakt , 14, 1893, 301) From larvae of the nun

moth (Lymantria monacha).

Bacillus columbarum Chester. (Bacillus of pigeon cholera, Moore, U.S. D.A., Bur Anim. Ind , Bull. 8, 1895; Chester, Man Determ. Bact., 1901, 209.) From a disease of pigeons. Hadlev et al (Rhode Island Agr. Exp Sta, Bull 174, 1918, 178) regard this as probably a paracolon.

constructus Zımmermann. Bacıllus (Zimmermann, Bakt, unserer Trink- u. Nutznässer, Chemnitz, 1, 1890, 42, Bacterium constrictus Chester, Ann. Rept. Del. Col Agr. Exp. Sta , 9, 1897, 112) From water

Bacillus convolutus Wright (Wright, Mem. Nat. Acad Scn., 7, 1895, 461; Bacterium contolutus Chester, Ann. Rept. Del. Col Agr Exp Sta., 5, 1897, 101.) From river water.

Bacillus coprogenes foetidus Sternberg.

(Darmbacillus, Schottelius, 1885; Sternberg, Man. of Bact., 1893, 468) From the intestinal contents of pigs which had died of swine erysipelas.

Bacillus coronatus Keck, (Inaug Diss., Dorpat, 1890, 43) From water. Bacillus corrí Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 394.) From

the stomach and intestines of birds. Bacillus courmontii Migula, (Courmont, Compt. rend. Soc. Biol., Paris, 1889: Bacillus pseudotuberculosis similis Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 454; Migula, Syst. d. Bakt., 2, 1900, 770.) From tubercles of cattle.

Bacillus crassus Lucet. (Bacıllus crassus pyogenes boris Lucet, Ann. Inst. Past , 7, 1897, 327; Bacillus crassus pyogenes Lucet, ibid., 327; Lucet, ibid., 328; Bacillus pyogenes crassus Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 343; Bacterium pyogenes crassus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 141; Bacellus boris Migula, Syst. d. Bakt., 2, 1900, 765.) From bovine abscesses. Regarded by Kruse as a synonym of Bacillus pncumoniae

Bacillus crinitus Migula. (No 15, Lembke, Arch. f. Hyg., 29, 1897, 321; Migula, Syst. d. Bakt., 2, 1900, 678) From feces.

Bacillus cubonianus Cuboni and Garbini. (Atti. dei Lincei, Scr. 4, 6, 1890, 26-27, quoted from Steinhaus, Bact. Assoc. Extracell, with Insects and Ticks, Minneapolis, 1942, 53, not Bacillus cubonsanus Macchiati, Staz. Sperim. Agr. Ital., 23, 1892, 228.) From silkworms (Bombyz mori).

Bacillus cuenoti Mercier. (Bakteri-Gebilden, Blochmann, enähnlichen Ztschr. f. Biol., 24, 1887, 1; Compt. rend. Soc. Biol., Paris, 61, 1906, 652; also in Arch. f. Protistenkunde, 9, 1907, 346) From the fat body of the cockroach (Persplaneta orientalis).

Bacillus cuniculi Migula. (Bacillus septicus cuniculi Lucet, Ann. Inst. Past., 6, 1892, 561; Bacillus cuniculi septicus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 406, Bacterium enniculi septicus Chester, Ann. Rept. Del. Col. Agr. Eq. 8ta., 9, 1897, 76; Migula, 8yst. d. Bakt., 2, 190, 758. Associated with

a spontaneous epizootic of rabbuts

Bacillus cuniculicida ummobilis Kruse

(Kruse, in 11ggg, Die Mikriorgaus men, 3 Aufl, 2, 1895, 417, Racterium cuniculicida immobilis Chester, Ann Rept Del Col Agr. Evp Sta. 9 1897 84; Bacterium cuniculicida var immobile Chester, Man Determ Bact, 1901, 149 ) Cauve of a disease of rabbits

Bacillus cystiformis Clado (Quoted from Sternberg, Man of Bact, 1893, 549). From urine in a case of cystitis

Bacillus custitidia Migula (Corco bacillus aerogenes resicae Schow, Cent f Bakt , 12, 1892, 749, Bacillus aerogenes testege Lehmann and Neuntann, Bakt Diag., 1 Aufl , 2, 1896, 237, Bacterium aerogenes testene Chester, Ann Rept Del Col Agr. Lyp. Sta. 9, 1897, 128, Migula, Syst d Bakt, 2, 1900, 771, Bacillus aerogenes Chester, Man Determ Bact , 1901, 227, not Bacillus aerogenes Miller, Deutsche med Wochnschr , 12, 1886, 119, not Bacillus aerogenes Kruse, in Plugge, Die Mikroorganismen, 3 Aufl , 2, 1896, 340 ) From urine in a case of cystitis

Bacillus dacryoideus Migula (Bacillus oogenes hydrosulfureus n. Zorkendörfer, Arch f. Hyg, 16, 1893, 389, Migula, Syst d. Bakt, 2, 1900, 791)

From hens' eggs

Bacillus decolor Eckstein. (Zischr f Forst- u Jagdwesen, 26, 1894, 15) From the larvae of a butterfly (Vanessa utricae)

Hiricae)
Bacillus decolorans major Dyar
(Ann. N Y. Acad Sci, 8, 1895, 362)
From air

Bacillus decolorans minor Dyar (Ann N Y Acad Sci., 8, 1895, 359) From air

Bacillus defessus Kern (Arb bakt Inst. Karlsruhe, 1, Heft 4, 1896, 397.) From the stomach and intestines of birds

Bacillus delta Dyar, (Dyar, Ann.

N. Y. Acad. Sci., 8, 1895, 368, Bacterium delta Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 111.). From water

Bacellus deutry/couns Gillay and Aberson (Giltay and Aberson, Arch. N/cel Sci exact et nat, 25, 1891, 341, quoted from Sternberg, Man of Bact, 1891, 725, not Bacellus deutrificans Migula, Syst d Bakt, 2, 1900, 796, not Bacellus deutrificans Chester, Man Determ Bact, 1801, 274). From soil and art

Bacillus demitra/horceccus van Herson (Cent I Bakt, H Abt, 9, 1902, 772, 12, 1901, 111) Fluorescent From soil. Bacillus dentalis (tridans Miller, Chiller, Die Mikroorganismen der Miller, Leipzig, 1889, 218) From eartous teeth

Bacellus dermaides Tataroff (Inaug Diss , Dorpat, 1891, 19) From water

Bacillus diaphanas Migula (Halibacterium pellucidum Fischer, Die Bakterien des Meeres, 1891, 22, Migula, Syst d Bakt., 2, 1990, 712) From sea water

Bacillus diffuens Doyen (Bacillus urinae diffuens Doyen, Jour d connaiss médic, 1859, 107, Doven, ibid, 108, not lacellus diffuens Castellana 1915, see Castellana and Chalmers, Man Trop Med, 3rd ed, 1919, 913) From urine Bacillus dispitatus Migula (Becillus No 7, Pansin, Arch 1 path Anat, 122,

1890, 443, Migula, Syst d Bakt, 2, 1900, 659) From sputum

Bacillus dissimilis Trevisan (Bacillus I, Leube, Arch f path Anat, 100, 1885, 556, Trevisan, I generi e le specie delle Batteriacce, 1889, 16) From urine

Bacillus domesticus Dyar (Dyar, Ann N Y Acad Szi, 8, 1895, 389, Bacterium damesticus Chester, Ann Rept Del Col Agr Exp Sta, θ, 1897, 110) From air

Bacillus droserus (Troili-Petersson)
Buchanan and Hammer. (Bacterium
droserae Troili-Petersson, Cent I Bakt,
II Abt, 33, 1913, I, Buchanan and Hammer, Iowa Sta Coll Agr. Exp. Sta,
Res Bull 22, 1915, 256) Isolated by
placing leaves of a sundew (Drosera
intermedia) in mills and isolating the

slimy milk organisms developing. Closely related to Bacicrium lactorubefaciens Gruber, according to Buchanan and Hammer.

Bacillus duclauzii (Miquel) DeToni and Trevisan. (Urotacillus duclauzii Miquel, Ann. d. Microgr., 2, 1889, 58; DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 963) From soware.

Bacillus eczemicus Trevisan. (I generi e le specie delle Batteriacee, 1889, 14.) From evudate in cases of eczema,

Bacillus egregius Zopf. (Quoted from Papenhausen, Arb. bakt. Inst. Karlsrube, 3, 1903, 59.) A reddish-yellow non-spore-forming rod

Bacillus elepsoideuz Migula. (Bacillus saprogenes vini v. Kramer, Die Bakterien in ihren Beziehungen zur Landwirtschaft, 2, 1892, 138; Migula, Syst d. Bakt., 2, 1900, 684.) From wine

Bacillus ellingionii Chester. (Bacillus No 21, Conn. Rept. Conn. (Storrs) Agr. Exp. Sta., 1893, 52, Chester, Man Determ. Bact., 1901, 264) From milk.

Bacillus emmans Weiss (Arb. bakt Inst. Karlsruhe, 2, Heft 3, 1902, 232.) From vegetable infusions

Bacillus emulsinus Fermi and Montesano. (Cent f Bakt, 15, 1894, 722) From air. Decomposes amygdalin

Bactillus endocarditidis Migula (Bacillus endocarditidis griseus Weichselbaum, Beitr. z. path. Anat , 4, 1889, 119, Bacterium endocarditidis griseus Chester, Ann. Rept. Del. Col. Agr. Exp Sta., 9, 1897, 88, Migula, Syst d. Bakt., 2, 1900, 750.) From a case of endocarditis

Bacillus engelmanni Trevisan (Bacterium chlorinum Engelmann, see Flugge, Die Mikroorganismen, 2 Auß., 1886, 289; not Bacterium chlorinum Migula, Syst d. Bakt. 2, 1900, 471, Trevisan, I generi e le specie delle Batteriacee, 1889, 18) Source not given.

Bacillus enteromyces Trevisan (Bacille des selles f, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 154; Trevisan, I generi e le specie delle Batteriacee, 1889, 15) From Icces. Bacillus entomotozicon Duggar. (Bull Hlinois State Lab. Nat. Hist., 4, 1896, 340-379.) From the squash bug (Anasa tristis).

Bacillus epsilon Dyar. (Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 369; Bacterium epsilon Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 114.) From air.

Bacillus equi Migula (Bacillus equi intestinalis Dyar and Keith, Technol Quarterly, 6, 1893, No. 3; abst. in Cent. f. Bakt., 16, 1891, 838; Bacterium equi intestinalis Chester, Ann. Rept. Del. Cod. Agr. Exp. Sta. 9, 1897, 70, Migula, Syst. d. Bakt., 2, 1900, 874; Bacillus intestinalis Chester, Man. Determ, Bact., 1901, 213.) From the intestines of a horse.

Bacillus crubescens Migula. (Bacillus oogenes hydrosid/ureus n. Eörkendörler, Arch. I. Hyg., 16, 1893, 391) Mygy. Syst. d. Bakt. 2, 1900, 702; Bacillus rubescens Nepveux, Thèse, Fac. Pharm. Paris, 1920, 113.) From Jens's (gss.)

Bactilus erythrogenes rugatus Dyar. (Ann. N. Y. Acad. Sci., 8, 1895, 374) A wrinkled variety of Bacillus lactis erythrogenes Hueppe.

Bacillus crythrosporus Mifici. (Mifici, in Cohn, Beitr. z. Eiol. d. Pflann., 8, Heft 1, 1879, 125; Bacillus (Streptobacter) crythrospores (sie) Schroeter, in Cohn, Krypt. Flora v. Seblez., 3, 1, 1886, 1886; Bacterium crythrosporus Chester, Ann. Rept. Del. Col. Agr. Lyo, Sta., 9, 1897, 123) From putrefying egg-white and meat infusion. According to Chester, the author mistook reddish granules for spores. Fluorescent.

Bacillus esterificans fluorescens Massen. (Arb. a. d. k. Gesundshoitsamte, 15, 1599, 501-507.) From grains and from rotting vegetation in river water. Bacterium esterificans stralauense Mas-

sen. (Arb. a. d. k. Gesundheitsamte, 15, 1599, 501-507.) From Spree River water

Bacillus eta Dyar (Dyar, Ann N Y. Acad. Sci., 8, 1893, 374; Bacterium eta Chester, Ann. Rept. Del. Col. Agr. Evp. Sta., 9, 1897, 107.) From air

Barillus ethaceticus Frankland an i

Frankland. (Proc. Roy. Soc. Loodon 46, 1889.) Ferments mannitol, glycerol and glucose to ethyl alcohol and acette acid with a trace of formic and succinic acids.

Bacillus ethacetosuccinicus Frankland and Frew. (Transactions of the Chem cal Society, 1892, 275.) Ferments mannitol and dulcitol to ethyl alcohol, acetic acid, succinic acid, hydrogen and car bonic acid.

Bacillus exapatus Trevisan (Bacillus der conjunctivalsack f, Fick, Ueber Mikroorg in Conjunctivalsack, Wiesbaden, 1887; Trevisan, I genen e le specie delle Batteriacce, 1889, 15) Found frequently 10 the humao eye

Bacillus eriquus Wright (Wright, Mem. Nat. Acad Sei, 7, 1805, 417, Bacterium eriquum Chester, Ano Rept Del. Col. Agr. Evp Sta. 9, 1897, 114, not Bacterium eriquum Stüubli, Münch ner med. Wochnschr., No 45, 1905) From water.

Bacillus famger Trevisan. (Bacillus bei Lrysipel am Kaninchenohr, Flügge, Die Mikroorgamsmen, 2 Auft, 1886, 223, Trevisan, I genen e le specte delle Batternace, 1889, 14.) From a case of crysipelas of the ear of a rabbit.

Bacillus felis (Rivolta) Trevisao (Cocco-bacterium felis Rivolta, Ciorn di Anatomia, No. 1, 1883; Trevisao, I genen e le apecie delle Batteriacce, 1889, 14.) From an infection in a cat

Bacillus fermentationis Chester (Bacillus foetidus liquefaciens Tavel, Ueber d. Actiol. d. Strumitis, Basel, 1872, Chester, Man. Determ. Bact, 1901, 233) From strumitis.

Bacillus ferrugineus Rullmann (Rullmann, Cent. f Bakt, I Abt, 24, 1898, 467; not Bacillus ferrugineus Vau Iterson, Cent. f. Bakt., 11 Abt., 11, 1203,

691) From ennal water. Bacillus ferrugineus Dyar. (Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 361, not Bacillus ferrugineus Itulimann, Cent. f Bakt, J. Abt., Ong. 24, 1893, 405, Bacterium Jurrugineus (sic) Chester, Ann. Rept. Del. Col. Agr. Exp Sts. 9, 1877, 115, Bacterium ferrugineum Chester, Man. Determ. Bact., 1901, 177) From air and from a fresh leaf of the pitcher plant (Sarracenia purpurea).

Bacillus fertilis DeToni and Trevisan. (Bacillus urinae fertilis Doyen, Jour d. eonnaiss médie, 1889, 107, DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 949) From urine

Bacillus figurans Vaughan. (Vaughan, Amer Jour Med Sci., 104, 1892, 107; not Bacillus figurans Crookshank, Man. of Bact, 1st ed., 1886) From water.

Bacillus finitimus ruber Dyar (Ann. N Y Acad Sci. 8, 1895, 361) From air

Bacillus flatudescens Migula (Bacillus aquatilus sulcatus v. Wechselbaum, Das Seterrechesche Sanitatusesen, 1889, No 14-23, Bacillus aqualitis sulcatus Kruse, in Flugge, Die Dikroorganismen, 3 Aufl. g. 1800, 382; Migula, Syst d Bakt. g. 1900, 731, Bacillus ueuksellaumus Chester, Man. Determ Bact. 1901, 218 From water

Bacillus flaroides Castellani. (Proc. Soc Exp Biol and Med , 25, 1928, 539.) From the human skin

Hacillus facus Echstein (Ztschr f. Forst. u Jagidneen, 25, 1804, 12, not Bacillus flavs Fuhrmann, Cent. f. Bakt, 11 Abt., 19, 1907, 117, not Bacillus flaus Bergey et al., Manual, 1st ed., 1923, 286) From deal larvae of a butterfly (Vanessa polychlorus)

Bacillus flexuosus Wright (Wright, Mem Nat Acad Sci., 7, 1895, 460; Bacterium flexuosus Chester, Ann. Rept. Del Col Agr Exp Sta., 9, 1897, 100) From river water

Bacillus foccous Kern (Kern, Arb bakt Inst Karlsruhe, I, Heft 4, 1806, 421, not Bacillus foccous Weinberg et al, Les Microbes Anacrobies, 1937, 698) From the stomach and intestines of birds.

Bacillus fluidy cans DeToni and Trevisan (Bacillus fluidy cans partus Maggora, Giorn. Soc. ital. d'Igiene, II, 1889, 311, DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 969) Front the skin Bakt. unserer Trink- u. Nutzwässer, Chemnitz, 1, 1890, 50; Bacillus gracilior Migula, Syst. d. Bakt., 2, 1900, 661.) From the stomach and intestines of birds.

Bacillus gracilis aerobiens Vaughan. (Amer. Jour. Med. Sci., 104, 1892, 187.) From water.

Bacillus gracilis anaerobiescens Vaughan. (Amer. Jour. Med Sci., 104, 1892, 187.) From water.

Bacillus gracilis eadqueris Sternberg. (Sternberg, Man. of Bact., 1803, 733; Bacterium gracilis cadveris Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 0, 1897, 84.) From the human liver.

Bacillus grandis Trevisan. (Bacille de l'air h, Babes, in Cornil and Babes, Les Bactérics, 2nd ed., 1886, 180, Trevisan, I generi e le specie delle Batteriacee, 1889, 20 ) From air.

Bacillus granulatus Chester. (Bacillus aquatilus solidus Lustig, Diag. Bakt. d. Wassurs, 1893; Bacterium aquatilis solidus Chester, Ann. Rept. Del. Col. Agr. Evp. Sta., 9, 1897, 76; Chester, Man. Determ. Bact., 1901, 223) From water.

Bacillus granulosus Losski, (Losski, Inaug Diss, Dorpat, 1893, 25; not Bacillus granulosus Russell, Ztschr. f. Hyg., 11, 1892, 99; not Bacillus granulosus Gerstner, Arb bakt Inst. Kral'such, 1, Heft 2, 1894, 107, Bacillus subgranulosus Migula, Syst. d Bakt., 2, 1900, 820) From sand on the Riga coast

Bacillus grarcolens Bordoni-Ulfreduzzi (Bordonu-Ulfreduzzi, Fortschr. d. Med., 4, 1886, 187, not Bacillus graveolens Russell, Ztechr f Hyg., 11, 1892, 99; not Bacillus graveolens Gottheil, Cent. f. Bakt., II Abt., 7, 1901, 496; Bacterium gravcolens Eisenberg, Bakt. Diag., 3 Aud., 1891, 108.) From skin between the toes

Bacillus gravetzi Trevisan (Bacillus der Aene Contaguesa des Flerdes, Dieckerhoff and Grawitz, Arch. f. path Annt., 102, 1885, 148; Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 13, Bacillus acues contaguesae Kruse, in Flügge, Die Mikroorganismen, 3 Aufl.,

2, 1896, 445; Bacterium acnes contagiosae Chester, Ann. Rept. Del. Col. Agr. Evp. Sta., 9, 1897, 89; Bacterium acnes Migula, Syst. d. Bakt., 2, 1900, 385; Bacterium pravititi Chester, Man Determ. Bact., 1901, 154.) From acne pusttes in horses.

Bacillus griseus Migula. (Grauer Bacillus, Keck, Inaug. Diss., Dorpat, 1891, 51; Migula, Syst. d. Bakt., 2, 1900, 785)

From water.

Bacillus haematoides Wright. (Wright, Mem. Nat. Acad. Sci., 7, 1895, 448; Bacterium haematoides Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 115) From river water.

Bacillus hajeki Trevisan. (Bacillus foetidus osaenae Hajek, Munch med. Woehnschr., 1887 and Berliner klin. Woehnschr., 1888, 662; Trevisan, I generi e le specie delle Batternace, 1889, 16; Bacillus osaenae Migula, Syst. d. Bakt., 2, 1900, 645; not Bacillus osaenae Abel, Cent. f. Bakt., 18, 1803, 167; Bacterum foetidus osaenae Chester, Ann. Rept. Del. Col. Agr. Evp. Sta., 9, 1897, 134.) From nasal mueus in human ozena.

Bacillus halobicus Horowitz-Wlassowa. (Ztschr. f. Unters. d. Lebensm., 62, 1931, 597) From brines used in salting fish.

Bacillus halophilus Russell. (Russell, Ztsehr. f. Hyg., 11, 1891, 200; Bacterium halophilus Chester, Ann. Rept. Del. Col. Agr. Evp Sta. 9, 1897, 93 and 135) From sea water and marine mud.

Bacillus havaniensıs Migula. (Bacillus havaniensis liquefacens Stenherg, Man. of Bact., 1893, 686; Bacterium havaniensis liquefacens Chester, Ann. Hept. Del. Col. Agr. Exp. Sta., 9, 1897, 97; Migula, Syst. d. Bakt., 2, 1900, 725, not Bacillus havaniensis Sternberg, loccit, 718) From the skin.

Bacillus helvolus granulatus Dyar. (Ann. N Y. Acad. Sci., 8, 1895, 374) Apparently a variety of Bacillus helvolus Zimmermann.

Bacillus heminecrobiophilus Arloing. (Compt rend. Acad. Sci., Paris, 107, 1883, 1169 and 108, 1889, 458.) From the lymph glands of an experimental guinea pig.

Bacillus hepaticus fortuitus Sternberg. (Sternberg, Man of Bact, 1823, 619, Bacterium hepaticus fortuitus Chester, Ann. Rept Del Col. Agr Exp Sta, 9, 1897, 136) From the liver of a yellowfever eadayer

Bacillus herrmannt Migula (Ein neuer Kapselbazillus, Herzfeld and Herr mann, Hyg. Rundschau, 5, 1895, 642, Migula, Syst d. Bakt, 2, 1900, 617) From a nasal secretion

Bacillus hofmanni Migula (Hofmann, Wochnschr f Forstwirtsch, 1891, No 1-6 and No 25-39, Migula, Syst d Bakt, 2, 1900, 742) From the larvae of the nun moth (Lymanina monacha)

Bacillus hudsonii Dyar (Ann N Y. Acad Sci, 8, 1895, 309, Bacterium hudsonii Chester, Ann. Rept Del Col Agr Evp Sia, 9, 1897, 106) From air

Bocillus humitis Trevisan (Baclérie de l'air No 1, Babes, in Cernil and Babes, Les Bactéres, 2nd ed , 1886, 140, Trevisan, I generi e le specie delle Batteriacce, 1889, 20) From air.

Bacillus hydrocharis Trevisan (Bacille de l'eau e, Babes, in Cornil and Babes, Les Ractéres, 2nd ed, 1886, 168; Trevisan, I geneti e le specio delle Balleriagee, 1889, 19) From water

Bacillus hydrosulfureus Migula (Bacillus oogenes hydrosulfureus f Törkendörfer, Arch f. Hyg, 16, 1893, 383, Migula, Syst d Bakt, 2, 1900, 695) From hens' eggs

Bacillus selerogenes Kruse. (Guar meri, Ace. med Roma, 87/88 and Vincent, Semaine médicale, 1897, 29, Kruse, in Flügge, Die Mikroorgrungmen, 3 Mil. 2, 1, 1890, 272, Bacterium ieterogenes Cles ter, Ann Rept Del Col Agr Exp Sta. 9, 1897, 69) From the liver and blood in cases of acute yellow atrophy

Bacillus incanus Polil (Polil, Cent I Bakt, 11, 1892, 112, Bacterium incanus Chester, Ann Rept Del Col Agr Exp Sta. 9, 1897, 99, Bacterium incannum (sie) Chester, Mun Determ Bact., 1901. 157. From swamp water. Bacillus indigogenus Alvarez. (Alvarez, Compl. rend Acad Sci., Paris, 103, 1887, 296, Bacterum indigogenus Cheslor, Ann Rept Del Col Agr Exp. Sta., 9, 1897, 136.) From an infusion of leaves of the indigo plant.

Bacillus innesi Trevisan. (Bacille de l'éféphantiasis des Arabes, Innes, Bull 1st. Égypt de 1886, Cairo, 1887; Trevisan, I generi e le specie delle Batteriacce, 1889, 13.) From the blood in cases of clenhantiasis in Ecvyt

Bacillus inodorus Trevisan (I generi e le specie delle Batteriacce, 1889, 16) From pus

Bacillus infestinus motilis Sternberg, (Sternberg, Man of Bact, 1833, 619, Bacterium infestinus motilis Chester, Ann Rept Del Col Agr Evp Sta., 9, 1897, 74) From intestines of yellow fever eadavers

Bacellus enutiles Dyar (Ann N. Y. Acad Sci, 8, 1895, 361) From sir.

Bacillus kappa Dyar (Ann N Y. Acad Sci. 8, 1895, 375) From diseased larva of a moth (Scoliopteryz libatriz). Bacillus Hebsii Trevisan (Bacillus

Bachins Heebs, Headed d path Anat., 1850 and Areb f exper. Pathol u Pharmae, JS, 1881, Helt-5-6; Trevisan, Car di ale nuov gen di Battr., 1855, 10, Trevisan, I generi e lo specie delle Ralternacee, 1859, 14; not Bacillus typhosus Zopf, Die Spaltpilee, 3 Auf., 1855, 196). Toma au intestinal necrosis.

Bacillus Meckii Migula (Bacillus butyri H, v Mecki, Cent f Bakt, 15, 1891, 360, Migula, Syst d Bakl, 2, 1900, 810) From rancid butter

(Bacillus

Bacillus Heinii Trevisan

de la diarrifice choleriforme, Klein, Micro organisms and Disease, 1885, 87; Trevisan, in DeTom and Trevisan, in Siceardo, Sylloge Fungorum, 8, 1889, 916, not Bacillus therm Migula, Syst. d Bakt. 2, 1900, 766, not Bacillus themi Buchuna and Hummer, Iowa Agr. Exp. Sia Res. Bull 22, 1915, 276) From the blood in fatal cases of choleraic diarribota.

Bacillus Heinit Migula. (Lin neuer

Bacillus des malignen Oedems, Klein, Cent. f. Bakt., 10, 1891, 186; Bacillus rseudo-oedematis maligni Sanfelice, Ztschr. f. Hyg., 14, 1893, 353; Bacillus oedemairs aerobicus Sternberg, Man. of Bact., 1883, 465; Bacillus oedematis aerobius Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 244; Bacterrum ocdematis aerobius Chester, Ann. Rept. Del. Col. Agr. Exp. Sta , 9, 1897, 75; Migula, Syst. d. Bakt., 2, 1900, 766; not Bacillus kleinti Trevisan, in De-Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 946; not Bacillus Aleinii Buchanan and Hammer, Iowa Agr. Exp. Sta. Res. Bull. 22, 1915, 276; Bacillus acrobius Chester, Man. Determ. Bact, 1901, 221.) From a guinea pig inoculated with soil.

Bacullus kornii Chester. (Bacillus bei einem Leberabseess, Korn, Cent. f. Bakt., 21, 1897, 438; Chester, Man. Determ. Bact., 1001, 252) From a case of

liver abscess.

Bacillus locius Chester. (Bacillus b, Guillebeau, Ann. Mierog., 11, 1803-1809, 225, Chester, Man Determ Bact., 1501, 238; not Bacillus lactis Neide, Cent. f. Bakt., II Abt., 12, 1504, 337) From milk.

Bacillus lactofoetidus Migula. (Bacil lus foetidus lactis Jensen, 22de Bereninig fra den Kgl. Veterin og Landbohöjskoles Laboratornum for landökonomiske Forsoeg, Copenhagen, 1891, 15; Migula, Syst. d. Bakt., 2, 1800, 740.) From tainted milk and butter.

Pacillus lanceolatus Mattes. (Sitzungsber d. Gesells z Beförderung d. gesam. Naturw. z. Marburg. 62, 1927, 381-417) From benign foulbrood of

bees (A pis mellifera).

Bacillus laricida Dyar. (Ann. N Y. Acad. Sci., 8, 1825, 377; Bacterium laricida Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 103.) From the exudate of a diseased larva of a moth (Clisiocampa fragilis).

Bacillus lassari Trevisan. (Bacillus des lichen ruber, Lassar, sec Flügge, Die Mikroorganismen, 2 Aufl., 1886, 239; Trevisan, I generi e le specie delle Batteriacee, 1889, 14.) From lichen ruber, a skin disease.

Bacillus lentiformis Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1806, 418.) From the stomach and intestines of birds.

Bacillus leptinolarsae White. (Proc. Ent. Soc. Wash., 50, 1928, 71; Jour. Agr. Res., 51, 1935, 223.) From discussed larvae of the Colorado potato-beetle (Leptinolarsa decemlineata).

Bacillus levogi Trevisan. (Bacille de la diarnhe verte des enfants, Lesage, Bull. Acad. Méd., Paris, October, 1887; Trevisan, I generi e le specie delle Batteriacce, 1889, 14; Bacillus rirdis Krue, in Flögge, Die Mikroorganismen, 3 Aufl., 2, 1806, 202; Bacterium viridis Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 8, 1897, 118.) Associated with green diarrhoea of children.

Bacillus limbatus Migula. (Bacillus limbatus butyri von Klecki, Cent. 1. Bakt., 16, 1894, 359; Migula, Syst. d. Bakt., 2, 1900, 62.) From rancid butter.

Bacillus limicola Russell. (Bot. Gaz., 18, 1803, 383.) From sea water and marine mud at Woods Hole, Massachusetts.

Bacillus lineatus Echstein. (2tschr. I. Forst- u. Jagdwesen, 26, 1891, 17) From larvae of the nun moth (Lymanina monacha).

Bacillus lineatus Migula, (Bakterie V, Weigmann and Zirn, Cent. f. Bakt. 15, 1894, 467; Migula, Syst. d. Bakt., £, 1900, 806; not Bacillus lineatus Eckstein, Zischr. f. Forst. und Jagdwesen, £9, 1894, 17.) From soapy milk.

Bacillus liparis Paillot. (Compt. rend. Acad Sci., Paris, 164, 1917, 527.) Fromlarvacof thegypsy moth (Porthetris

(Limantria) dispar).

Bacillus liquefaciens Doyen (Bacillus urinae liquefaciens Doyen, Jour. d. connaiss. médie., 1889, 188; Doyen, idem; not Bacillus liquefaciens Fiscaberg, Bakt. Diag., 3 Aufl., 1891, 112.) From urine.

Bacillus liquefaciens Migula. (Bacil-

lus sulcatus liquefociens Kruse, in Plugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 318, Migula, Syst d Bakt, 2, 1900, 723, not Bacillus liquefaciens Lisenberg, Bakt. Diag , 3 Aufl , 1891, 112 ) From water.

Bacillus liquefaciens albus Vaughan (Amer. Jour Med Sci., 104, 1892, 185.) From water

Bacillus liquefaciens compunis Stern (Sternberg, Man of Bact , 1893, 656; Bacterium liquefacient communit Chester, Ann Rept Del Col Agr Exp Sta. 9, 1897, 137.) From the feees of yellow fever patients Considered by Chester (loc cit., 91) to be synonymous with Bocillus aquotilis communis Kruse

Bocillus liquidus communis Sternberg (Manual of Bact, 1893, 686) From feces

Bacillus litorosus Russell (Bot Gaz, 18, 1893, 414) From sca water and marine mud at Woods Hole, Massa-

chusetts Bocillus loxtocida Tartakonsk) (Arch. d Veterinarwiss, 1883, quoted from Chester, Man Determ Bact, 1901, 211) Associated with an in-

fectious disease of crossbills Bocillus lucidus Migula (No Lembke, Arch f Hyg, 26, 1896, 203, Migula, Syst d Bakt , 2, 1900, 674 )

From feces.

Bacillus lups Trevisan (1 generi e le specie delle Batteriacce, 1889, 12) From lupus, a skin disease

Bacillus lupini Migula (Bacillus tu berigenus 7, Gonnermann, Landwirtsch Jahrb , 23, 1894, 657; Migula, Syst d Bakt . 2, 1900, 793 ) From root nodules on lunine.

Bacillus lustigis Trevisan, (Bacillo moffensivo del Mytilus edulis, Lustig, Arch per le sci med., 12, 1887, 17, Trevisan, see De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 958; not Bucillus lusticii Carbone and Venturelli, Boll Ist. Sieroter., Milan, 4, 1925, 59 ) From the liver of a mussel (Mytilus edulis).

Bacillus luteo-albus Beijerinck(Botan Zeit., 46, 1888, 749.) From root nodules on legumes

Bacillus lutcliensis Chester. (Bacillus tiolaceus lutetiensis Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896. 311, Chester, Man Determ. Bact., 1901. 306) From water.

Bacillus luteus Tlugge (Die Mikroorganismen, 2 Auff , 1886, 200; not Bacillus luteus von Dobrzyniecki, Cent f. Bakt , I Abt , 21, 1897, 835, not Bocillus luteus Garbowski, Cent f Bakt., II Abt . 19, 1907, 611.) From air Bacillus lumantriae Picard and Blanc.

(Picard and Blanc, Compt rend Acad Sei , Paris, 167, 1913, 80, Bacillus lymontria a Paillot, ibid , 168, 1919, 258; Bacillus (Bactersum) lymantrioe l'aillot, L'infection chez les insectes, 1933, 131; Coccobacellus lymontriae Steinhaus, Catalogue of Bacteria Associated Extracellularly with Insects and Ticks, Minneapolis, 1912, 64 and 183 ) From disensed larvae

of the gypsy moth (Porthetria (Lyman-Bacillus Immontriae & Paillot. (Compt. rend Acad. Sci., Paris, 168, 1919, 258 ) From diseased larvae of the gypsy moth (Porthetria (Lymontrio) dispor).

tria) dispar)

Bacillus lumantricola odiposus Paillot. (Compt. rend. Acad Sci., Paris, 168, 1919, 258; Bartersum lymantricola adsposus Pailtot, L'infection chez les inseetes, 1933, 135 ) From caterpillars of Porthetria (Lumantria) dispar

Bacillus madidus Migula (No 5, Lembke, Arch. [ Hyg. 26, 1895, 300, Migula, Syst d Bakt, 2, 1900, 812) From bread.

Bacillus maggiorge DeToni and Trevisan (Bacillus B. Maggiora, Giorn Soc stal. d'Igiene, 11, 1889, 310, DeToni and Trevisan, in Saccardo, Syllege Fungorum, 8, 1889, 968 ) From the skin of the human foot and from air.

Bacillus mayor Doyen (Bacillus uringe major Doyen, Jour d connaiss, médic... 1889, 107; Doyen, sbid, 108.) From urine.

Bacillus malariae Klebs and Tommasi-Crudeli. (Arch f. exper. Pathol., 2. water.

1879.) From swamp soil. See Sternberg, Man. of Bact., 1893, 523.

Bacillus mammitidis Migula. (Bacillus a, Guillebeau, Ann. de Microg., 2, 1800, No 8; Migula, Syst. d. Bakt., 2, 1900, S10) From the milk of cows having mastitis.

Bacillus manganieus Beijerinek. (Folia Microbiol., Delft, 2, 1913, 130.) From soil. Motile. Is able to oxidize

manganese carbonate,

Bacillus margarineus Migula. (Diplococcus capsulatus margarineus Jolles and Winkler, Ztschr. f. Hyg., 20, 1895, 103, Migula, Syst d. Baht., 2, 1900, 691.) From margarine.

Bacillus maricola Migula (Halibacterium polymorphum Fischer, Die Baktierien des Meeres, 1894, 36; Migula, Syst. d Bakt, 2, 1900, 709.) From sea

Bacillus marsilliensis Kruse. (Bacilius of Murseilles swine plague, Rietsch and Jobert, Compt. rend Acad Sci., Parus, 106, 1888, 1036, Kruse, in Flugge, Die Mikroorganismen, 3 Auft., 2, 1896, 045, Bacterium marsilensis Chester, Ann Rept. Del Col Agr. Exp Sta., 9, 1897, 07) Associated with a disease of swine.

Bacillus martinez Sternberg (Sternberg, Man of Bact, 1893, 631, Bacillus martinezu Dyar, Ann N Y Acad, Sci, 8, 1895, 364, Bacterium martinezu Chester, Ann Rept. Del Col Agr Exp. Sta, 9, 1897, 83.) From the liver of a yellow fever cadaver. Dyar isolated an organism from the air to which he applied Sternberg's name as the descriptions of the two species did not disagree

Bacillus melcagridis Migula (Mc-Fadycan, Jour Comp Path and Therap., 6, 1893, 334, Migula, Syst d Bakt, 2, 1900, 770, Bacillus melcagras Chester, Man Determ Bact, 1901, 220) The cause of epizootic pneumo-carditis in turkeys

Bacillus melleus Schroeter. (In Cohn, Kryptog Flora v Schlesien, 3, 1, 1886, 153) From feces and other sources

Bacillus melolonthae Chatton (Compt.

rend. Acad. Sci., Paris, 156, 1913, 1703.) From diseased cockehafers (Melolontha melolontha).

Bacillus melolonthae liquefaciens  $\alpha$ ,  $\beta$  and  $\gamma$  Paillot. (Compt. rend. Acad. Sci., Paris, 167, 1918, 1046; Annates des Épiphyties,  $\delta$ , 1922, 108-110; B. melolonthae liquefaciens  $\alpha$ ,  $\beta$  and  $\gamma$  Paillot, L'infection chec les insectes, 1933, 173, 196 and 189 respectively. According to the index the B. is used for Bacterium) From diseased cockchafers (Melolontha melolontha)

Bacillus melolonthae non-liquefaciena α, β and γ Paillot. (Compt. rend Acad. Sci., Parıs, 163, 1916, 553; Annales des L'piphytics, 8, 1922, 111-113) From discased eockchafer (Melolontha melolontha).

Bacillus melolonthae non-liquefaciens & Paillot. (Compt. rend Acad Sci., Paris, 167, 1918, 1016; Annales des Épiphyties, &, 1922, 113.) From diseased cockchafers (Melolontha melolontha).

Bacillus melolonthae non-liquefaciens e Paillot. (Compt. rend. Acad. Sci., Paris, 169, 1919, 1122; Annales des Épiphyties, 8, 1922, 114.) From discased cockchafers (Melolontha melolontha).

Bacillus membranaceus Kern. (Arb bakt Inst. Karlsruhe, 1, Heft 4, 1896, 407.) From the stomach and intestines of a bird.

Bacillus meningitidis Migula (Bacilus aerogenes meningilidis Centanii, Arch. per le scienze mediche, 17, 1833, No 1; Bacterium meningitidis aerogenes Chester, Ann Rept. Del. Col. Agr Exp Sts. 9, 1807, 96, Migula, Syst. d Bakt. 2, 1900, 642; Bacillus radiatus Chester, Man. Determ Bact., 1901, 241.) From tno cases of meningitis.

Bacillus metabolicus DeToni and Trevisan (Bacillus H, Maggiora, Giorn. Soe itad Hjeinet, H. 1889, 350; DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 968) From the skin of the human foot

Bacilius metoflavus Castellani. (Proc. Soc. Expt. Biol and Med., 25, 1928, 539)
From the human skin.

Bacillus minimus Eckstein (Ztschr f. Forst. u. Jagdwesen, 26, 1894, 16) From caterpillars of the nun moth (Lymantria monacha).

Bacillus minutissimus Migula (Bacillus aureus minutissimus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl, 2, 1896, 441; Migula, Syst d, Bakt, 2,

1900, 833 ) From air

Bacillus mitidus Henrici (Arb hakt Inst Karlsruhe, 1, Heft 1, 1894, 29) From Gouda cheese.

Bacillus mobilissimus Migula (Bacillus oogenes hydrosulfureus 8, Zouken dörfer, Arch f. Hyg, 16, 1893, 390, Migula, Syst. d. Bakt, 2, 1900, 791) From hens' eggs.

Bacillus mollis Doyen (Bacillus urinae mollis Doyen, Jour d connaiss médic., 1889, 107; Doyen, ibid, 108) From urine

Bacillus morulans Boucquet (Phytopath, 7, 1917, 286) From diseased sugar heets Associated with eurly top of sugar beet

Bacillus mollet Trevisan (Motte and Protopopofi, Wratech, 1857, No 21, 415; abst in Cent f Bakt, 2, 1887, 450, Trevisan, I generi e le specet delle Batteriaece, 1880, 123 Associated with a rables-like disease of rabbits and dogs Bacillus (f) multiforms Cartellani.

(Proc Soc Exp. Biol and Med , 25, 1928, 539) From the human skin

Bazillus murnus Chester (Bacillus of rat plague, Issatschenko, Cent f Bakt, £3, 1898, 873; Chester, Man Determ Baet, 1901, 221, not Bueiflus murnus Schmeter, in Coln, Kryptog Flora v Schlesten, 3, 1886, 162) From the spleen and liver of rats attacked in St Peter-bung by a plague by

Bacillus mycogenes Edwards (Jour Inf Dis 2, 1905, 431, Bacterium muco genum Edwards, idem) From exudate of wound infections Belongs to the Bacillus mucosus capsulatus group

Bacillus mytili Trevisan (Bacillo pa togeno del Mytilus edulis, Lustig, Arch per le Sci incel , 12, 1887, 17, Trevisan, see DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 958) From the liver of a mussel (Mytilus edulis) Bacillus naphthalinicus liquefaciens Tausson (Plants. 4, 1927, 214) From

oil-soaked soils at Baku, Russia Oxidizes naphthalene.

uzcs napotnaiene

Bacillus naphthalinicus non-liquefaciens Tausson. (Planta, 4, 1927, 214) From ed-soaked soils at Baku, Russia. Oudizes naphthalene.

Bacallus nebulosus Migula (Bacallus tuberngeuus S. Gonnermann, Landuntech Jahrb 28, 1894, 656, Migula, Syst d Badt, 2, 1900, 481, not Bacallus nebulosus Wright, Mem Nat. Acad Sci., 7, 1894, 465, not Bacallus nebulosus Hallé, Thèee de Paris, 1893; not Bacallus nebulosus Vincent, Ann. Inst Past , 21, 1907, 60, not Bacallus nebulosus Gorcsine, Jour Bact, 27, 1934, 52) From root nodules on lupine

Batillus necans Trevisan. (Bacille consécutí au charbon, Babes, in Cornul and Babes, Les Bactéries, 2nd ed., 1886, 231, Trevisan, I goneri e le specie delle Batteriacce, 1889, 14) From rabbits dead from anthrav.

Bacillus nephriticus Trevisan. (Bacille de la néphrite bactérienne, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 373, Trevisan, I genen e le specie delle Batteriacce, 1889, 14.) From unice in cases of nephritis

Bacillus neuralomae Paillot (Compt. rend Acad Sci., Paris, 178, 1924, 247; probably identical with Bacierium neurotomae Paillot, L'Infection chez les insectes, 1933, 146) From discassed larvae of a sawfly (Veuroloma nemoralis L).

Bacillus nitens Migula (Bacillus oogenes hydrosulfureus 1, Zörkemlorfer, Arch 1 Hyg, 16, 1893, 390, Migula, Syst d Bakt, 2, 1900, 793) From hens' eggs

Bacillus ochroleucus Migula. (Bacillus oogenes hydrosuljureus e. Zörkenderfer, Arch f Hyg. 18, 1893, 387; Migula, Syst d Bakt, 2, 1900, 841) From hens' eggs

Bacillus odorotus Wines (Weiss, Arb bakt Inst Karlsruhe, 2, 1902, 213, not Bacillus odoratus Migula, Syst. d. Bakt., 2, 1900, 686; Bacterium odoratum Omeliansky, Jour. Bact., 8, 1923, 394.) From fermented beets.

Bacillus odorificans Migula. (Weisser stinkender Bacillus, Maschek, Bakt. Untersuch. d. Leitmeritzer Trinkwasser, Leitmeritz, 1887; Migula, Syst. d. Bakt., 2, 1900, 711.) From water. Intenso

odor resembling that of liquid manure.

Bacillus odoryficus Omchansky.

(Jour. Bact., 8, 1923, 393.) Probably
intended for Bacillus odorificans Migula.

Bacillus odorus Henrici. (Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 30.) Fram cream cheese.

Bacillus conergasius Trevisan. (Bacille du mucus intestinal normal e, Babes, in Cormi and Babes, Les Bactéries, 2ad ed., 1886, 153; Trevisan, I gener e le specie delle Batteriacee, 1889, 15) From normal intestinal mucus.

Bacillus osleomyeliticus Trevisan. (Bacille de l'ostéemyélite, Rodet; Trevisan, 1884; see Trevisan, I generi e le specio delle Batteriacee, 1889, 16) From a case of osteomyelitis.

Bacillus oxylacticus Dyar. (Ann. N. Y. Acad. Sci., 8, 1895, 369.) Culture received from Král's laboratory labeled Bacillus oxylacticus, also from air.

Bacillus pallescens Migula. (Bacillus luteus pallescens Losski, Inaug. Diss., Dorpat, 1893, 44, Migula, Syst. d. Bakt, 2, 1800, 819) From garden soil.

Bacillus pallidus Schroeter. (Schroeter, in Cohn, Kryptog Flora v. Schlesien, 5, 1, 1886, 183, not Bacillus pallidus Bredemann and Heigener, Cent f Bakt., II Abt., 93, 1935, 98.) From cooked potato

Bacillus panificans Laurent (Bull. Soc R. Bot Belg, 1885, 175) From

fermenting dough

Bacillus pannosus Kern (Arb. bakt Inst. Karlsruhe, 1, Heft 4, 1866, 409.) From the stomachs and intestines of birds

Bacillus pansimi Migula (Bacillus No. 12, Pansimi, Arch f. path. Anat, 122, 1890, 477; Migula, Syst. d. Bakt., 2, 1900, 660.) From sputum.

Bacillus parallelus Edson and Carpenter. (Vermont Agr. Esp. Sta. Bull. 167, 1912, 593.) From maple sap. Cap-

sulated. At times Icebly fluorescent. Bacillus paullulus Trevisan. (Bacille de l'air d, Babes, in Cornil and Babes, Les Bactérics, 2nd ed., 1886, 149; Trevisan, I generi e le specie delle Batteriacce,

san, I generi e le specie delle Batteriacce, 1889, 20.) From air.

Bacellus pectinophorae White and

Noble. (Jour. Econ. Entomol., 29, 1930, 123) From diseased pink bollworm larvae (Pectinophora gossypiella).

Bacillus pediculi Arkwright and Bacot. (Parasitol, 13, 1921, 26) From the genital apparatus of the louse (Pediculus humanus).

Bacillus pellucidus Doyen (Bacillus urnae pellucidus Doyen, Jour. d. connaiss. médic., 1889, 107; Doyen, tbid., 108; not Bacillus pellucidus Kern, Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896,

404.) From urine.

Bacillus perlibratus Beijerinek.
(Cent. f. Bakt., 14, 1893, 831.) From a

bean infusion.

Bacillus perroncut Trevisau. (tacillo della pneumonite nodulare dei vitellini, Perroncito, Parassiti dell'uome e degli animali utili, 1882, 52; Trevisan, I generi e le specie delle Batteriacce, 1889, 13.)

From pulmonary nodules in contagious

pneumonia in calves

Bacillus petersti Migula. (Bacterum
B. Peters, Botan. Zeit., 47, 1889; Bacterium acudi lactici Kruse, in Flurge,
Die Mikroorganismen, 3 Aufl., 2, 1806,
Die Mikroorganismen, 3 Aufl., 2, 1807,
Die Mikroorganismen, 3 Aufl., 2, 1807,
Die Jacterium acid lactici Zepti, Die
Spaltpilre, 2 Aufl., 1881, 60; not Hacterum acidi lactici I and II Grotenfelt,
Fortscht, d. Med. 7, 1889, 123; not Hacterum acidi lactici Migula, in Engler

Land Prantt, Die natürl. Pilanzenfam,
I, 1a, 1895, 25; Migula, Sot. d. Bakt,
2, 1800, 799) From ferneting dough
Probably Bacterum letans Wolffin.

Bacillus phenanthrenicus bal tensis Tausson (Planta, 5, 1928, 239.) From soil. Utilizes phenanthrene and other hydrocarbons.

Bacillus phenanthrenicus guricus Tausson. (Planta, 5, 1928, 233) From soil Utilizes phenanthrene and other by dracarbons.

Bacillus phenologenes Berthelot (Ann. Inst. Past., 52, 1918, 20 : I rom feces. Forms phenol

Bacillus pierus agilis Paillot (Compt rend. Acad. Sci., Paris, 168, 1919, 177) From diseased caterpillars of the cabbage butterfly (Pieris brassieae)

Bacillus pieris fluorescens Paillot (Compt. rend Acad Sci., Pans. 168, 1919, 477; Ann. Épiphyt. 8, 1922, 124) From diseased caterpillara of the cab bage butterfly (Pieris brassicae).

Bacillus piers liquifacies l'ailloi (Campt. rend Acal Sei, Paris, 168, 1919) 477; Bacillus pieris liquifaciens a Paillot, Annales des Epiphytics, 8, 1922, 125 ) From diseasci enterpillars of the cabbage butterfly (Pieris brasicae) If this author followed his usual custom, thus is identical with his Bact pieris hyufaciens in his book, L'infection cher les insectes, 1933, 135.

Bacillus puris l'igurfaciens a l'aultoi (Anniles des Épiphyties, 8, 1922, 126, name occurs as B. pieris liquifaciens à Pailloi, L'infection chez les insectes, 1933, 297 According to the index B stands for Bacterium.) From diseased caterpillars of the cabbage (Pieris brassicae)

Bacillus pieris non liquefactures a Pail lot. (Compt. rend. Acad. Sc., Paris, 168, 1919, 477, B. pieris non-liquefactus & Paillot, Unifection cher les insectes, 1933, 135 ff. According to the index B stands for Bacterium.) From the cabbage butterfly (Pieris brassicae)

Bacillus pierus non-lique/actens β Pail lot. (Compt rend Acad. Sci., Paris, 168, 1919, 474; B pierus non-lique/actens β Paillot, L'infection chee les insectes, 1933, 299, according to the index, the B stands for Bacterium) From discased caterpillars of the cabbage butter-fly (Pieris brassicae).

Bocillus pleomorphus Migula. (Bacillus muriseptus pleomorphus Karlideth, Cent. f. Bakt., 5, 1889, 193; Bacterrum murisepticus pleomorphus Chester, Ann. Rept. Del. Col. Agr. Exp. Stn. 9, 1887, 102, Migula, Syst. d. Bakt., 2, 1900, 619, Bacillus murisepteus Chester, Man Determ. Bact., 1901, 247; not Bacillus murisepticus Plege, Die Altkroorganismen, 2 Aufl, 1886, 250) From pus.

Bacillus plicatus Frankland and Frankland (Philos Trans, Roy Soc London, 178, B, 1888, 273, not Bacillus plicatus Zimmermann, see Frankland and Frankland, Microorganisms in Water, London, 1894, 459) From iir.

Bacillus plumbeus Migula (Grau verliussigender Bacillus, Reck, Inaug. Diss., Dorpat, 1809, 51, Migula, Syst. d Bakt., 2, 1800, 719.) From water

Bacillus pneumo-enteritidis murium Schilling (Arb a d kuseil, Gesundheitsamie, 18, Heft 1, 1900) From a disease of rats

Bocillus previncerpteus Kruse. (Preumonie bacillus, Klein, Cent. f. Bakt, 6, 1889, 623, Kruse, in Flügge, Der Mikroorganismen, 3 Auft, 2, 1800, 40X, not Beseillus precincesphicus Babes, Progrès méd roumain, 6, 1859, Bacterium preumosepticus Chester, Ann. Rept Del Cel Agr Exp Sta, 9, 1807, 76) From rusty sputum Considered the cause of an epulemic of pneumonia in England

Bacillus poelsii Chester (Vleeschvergiftung te Rotterdam, Poels and Dhont; Tweede Rapport van de des Kundigen, Chester, Man Determ, Bact., 1901, 209.) From beef in meat poisoning.

Bacillus pomodoriferus Castellani. (Proc. Soc. Exp. Biol. and Med., 25, 1928, 540.) From the urine in a case of cystitia and from feces

Bacillus ponces Glaser. (Ann. Entomol Soc. Am., 11, 1918, 19) Pathogenie for the insects, Melanoplus femurrubrum and Encoptolopus sordidus.

Bacillus praepollens Maassen (Arb a d. kaiseri. Cesundheitsamte, 15. 1899, 507.) From sweat of a cholera patient.

Bocillus primus fullesi Dyar. (Ann. N. Acad. Sci., 8, 1895, 360; Bacterium N. Y. Acad. Sci., 8, 1895, 360; Bacterium Primus fullesi Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 72.) From a leaf of the pitcher plant (Sarracenia purpurea). Regarded by Dyar asidentical with Bacillus No. 1, isolated by Fulles (Zischr. I. Ilyg., 10, 1891, 250) from forest soil.

Bacillus promissus Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 120.) From the intestines of a dove.

Bacillus proteidis Paillot. (Annales des Épiphyties, 8, 1922, 130) From discased larvae of the cabbage butterfly (Pieris brassicae).

Bacillus proferrus Trevisan (Bacillus der Conjunctivalsack, d. Piek, Microorgan in Conjunctivalsack, Wiesbaden, 1887; Trevisan, I generi e le specie delle Batteriacce, 1889, 17) From the conjunctiva

Bacillus prudden: Dyar (Ann. N. Y. Acad Sci, 8, 1895, 378.) Found by Dr. Prudden in a case of cystitis

Bacillus pseudomirabilis Migula. (Bacillus mirabilis Taterofi, Inaug. Diss., Dorpat, 1831, 18, Migula, Syst. d Bakt., 2, 1900, 818) From water. According to Migula, Tateroff mistakenly believed that he had Zimmermann's Bacillus mirabilis.

Bacillus pseudotuberculosis Migula. (Du Cazal and Vaillard, Ann. Inst. Past., 5, 1891, 353, Hacillus pseudotuberculosis liquefacieus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 455; Migula, Syst d Bakt., 2, 1900, 644) From nodules in the peritoneum

Bacillus pseudotyphosus Kruse. (Losener, Arb a d kausel. Gesundhertsante, II, 1855, 2, Kruse, in Tlugge, Die Mikroorganismen, 3 Aufl, 2, 1896, 383; Bacterium pseudotyphosus Chester, Ann. Rept Del Col Age Exp Sta, 9, 1897, 73, not Bacterium pseudotyphosum Migula, Syst d. Bakt, 2, 1900, 428 } Isolated by Losener from peritoneal fluid of a hog, from water, etc.; by Pansim from a liver abscess; by Babes from a variety of sources. Kruse used this as a general name for any typhoid-like organism.

Bacillus pulpae pyogenes Miller. (Miller, Die Mikroorganismen der Mundhöhle, Leipzig, 1889, 219.) From gangrenous pulp of a tooth.

Bacillus punctatus Shul'gina and Kahnicker. (Rep. Bur. Appl. Ent. Leniagrad, 5, No. 1, 1927, 99-104, quoted from Steinhaus, Bact. Assoc. Extracell. with Insects and Ticks, Minneapolis, 1932, 72; not Bacillus punctatus Zimmermann, Bakl. unserce Trink. u. Nutzwasser, Chemnitz, I Reibe, 1880, 283. From the locust (Locusta migratoria).

Bacillus puncticulatus Migula (No. 16, Lembke, Arch. f. Hyg., 29, 1897, 322; Migula, Syst. d. Bakt., 2, 1900, 678) From feces.

Bacillus putidus Kern. (Kern, Arb bakt. Inst. Karlsruhe, I, Heft 4, 1804, 400, not Bacillus putidus Chester, Man. Determ. Bact., 1901, 237; not Bacillus putidus Weinberg et al., Les Microbes Anaérobies, 1937, 790.) From the stemach and intestines of birds.

Bacillus pylors Ford. (Studies from the Royal Victoria Hosp., Montreal, 1 (5), 1903, 44; also see Jour. Med. Res., 1, 1901, 217.) From the stomach.

Bacillus pyogenes Lucet. (Bacillus pyogenes bovis Lucet, Ann. Inst. Past., 1833, 372, Lucet, bid., 328; not Bacillus pyogenes Clage, Ztschr. f Fleish u. Milchhyg., 15, 1903, 166.) From bovine abscresses

Bacullus pyogenes var. liquefacens Chester. (Bacullus pyogenes foetidus liquefacens Lanz, Cent f. Bakt, 14, 1833, 277; Bacterium pyogenes foetidus liquefacens Chester, Aun. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 92; Chester, Man. Determ. Bact, 1901, 235) From a brain abscess after otitis media.

Bacillus pyogenes soli Bolton. (Ann Jour Med Sci, June, 1892, quoted from Sternberg, Man of Bact., 1893, 728.) From garden earth.

Bacillus pyrameis I and II, Paillet. (Compt. rend. Acad. Sci., Paris, 157,

1913, 611.) From tissues and blood of the caterpillar of Pyrameis (Vancesa) cardus. A coccobacillus.

Bacillus radians Trevisan (Bactérie de l'air No. 2, Babes, in Cormi and Babes, Les Bactéries, 2nd ed. 1886, 140, Trevisan, 1 generi e le specie delle Batteriacce, 1884, 20.) Fram air.

Bacillus ramificous Migala (Bacillus No. 9, Paneuni, Arch. 1 path Anat. 422, 1890, 445; Migula, Syst. d. Bakt., 2, 1990, 661; Bacillus pansina Chester, Man, Determ Bact., 1901, 216, not Bacillus pansini Migula, loc. cit., 660.) From soutum.

r rom spurum

Bacillus recupératus Wright (Wright, Mem. Nat. Acad Ses., 7, 1895, 433, Bac terium recuperatus Chester, Ann Rept Del. Col. Agr. Exp. Sta., 9, 1807, 74.) From Schuy Hill River water

Bacillus repasis Herter (Bacillus moliniformis Repasi, Compt rend Soe Biol, Paris, 68, 1910, 410; not Bacillus montiformis Garmer, Arch. Méd expér et Anat. pathol., 19, 1908, 785, Hecter, in Just's Botan Jahresher, 39, 2 Abt.,

Heft 4, 1015, 750) From a lung abscess Bazillus rhinitis atrophicans Paulsen (Paulsen, quoted from Chester, Ann Rept. Del. Col. Agr. Exp. Sta. 9, 1897, 79, Bacterium rhinitis atrophicous Chester, ibid., 141) From nesal secretions

Bacillus rigidus apis White (Jour Path. and Bact., 24, 1921, 70) From

intestine of bee.

Becellus rogerii Miguli Becellus septicus putitius Roger, Revine de Méd., 1891, 10, Migula, Syst. d Bakt. 2, 1900, 647, Bacterium septicus putitus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 92, Bacillus putitus Chester, Man Determ Bate, 1901, 237, not Beatilus putitus Kern, Arb. bakt. Inst. Karlsruthe, 1, Hert 4, 1896, 490, not Beatilus putitus Weinberg et al., Les Microbes Amaérobies, 1907, 790). From the spinal fluid and hver in aease of cholera.

Bocillus rosaccus Miguia. (Bacillus rosaccus margarinicus Jolles and Winkler, Ztschr. f. Hyg., 20, 1805, 105; Migula, Syst. d Bakt., 2, 1900, 859.) From margarine Red pigment.

Bacillus rosaceus metaloides Dyar. (Racterum rosaceus metaloides Douderwell, Ann. de Micrographie, 1, 1888-89, 310, Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 376, not Bacillus rosaceus metaloides Tataroff, Insuy Doss, Dorpat, 1891, 65, see Hefferan, Cent. f. Bakt., 11 Abt., 8, 1902, 689; Bacterium rosaceum Lebmann and Neumann, Bakt. Diag. 2 Aufl., 2, 1899, 261). Culture from Dr. Crookshank, London.

Bacilus roseus Migula (Halbacterum roseum Fischer, Die Bakterinders Meeres, 1894, 22, Migula, Syst. d. Bakt., 2, 1000, 870, Bacillus roseus fischer Nepucux, Thèse, Tac. Plann-Paris, 1920, 115) From sea water Red nument

piginene Racill

Bacillus rozenthalis Migula. (Rosenthal, Inaug Diss., Berlin, 1893, 37; Migula, Syst d. Bakt, 2, 1900, 656) From the oral cavity

Bacillus rubescens Edington (Ann. Rept Pish Board for Scotland, 6, 1887, 201) From reddened salted codfish

Bacillus rubescens Jordan (Jordan, Massachusetts State Board of Health, Boston, 1870, 835, Bacterium rubescens Chester, Ann Rept Del. Col. Agr. Exp. Sta. 9, 1897, 115) From sewage.

Bacillus rubiginosus Catiano. (In Cohn, Beitr z Biol d Pflanzen, 7, 1896, 53%) From the vagina. Red numement.

Bacillus rubiformis Kern (Arb bakt Inst Karlsrube, 1, Heft 4, 1896, 431) From the stomach of a bird

Bacıllus rubrofuscus (Fischer) Migula (Halbacterium rubrofuscum Fischer, Die Bakterien des Mecres, 1894, 36, Migula, Syst d Bakt, 2, 1900, 865) Trom sea water.

Bacillus rubus (sie) Chester (Der rother Bacillus, Lustig, Ding d Baht dd. Wassers, 1893, 72, Bacillus ruber aquatilis Kruse, 1n Flugge, Die Mikroorganismen, 3 Aufl. 2, 1896, 303, Bacterium ruber aquatilis Chester, Ann Rept Del. Col Agr. Exp Sta., 9, 1897, 112, Chester, Man. Determ. Baet., 1901, 257; Bacillus lustiga Chester, ibid., 301.) From water.

Bacillus salmoneus Dyar. (Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 361; Bacterium salmoneus Chester, Ann. Rept. Del. Col. Agr. Evp. Sta., 9, 1897, 116.) From air.

Bacillus salutarius Metchnikoff. (Metchnikoff, Maladies des hannetons du ble, Odessa (in Russian), quoted from Paillot, L'infection chez les insectes, Paris, 1933, 123.) From diseased lavvao of a beetle (Anisovilia austriaca).

Bacillus sanguineus Schroeter. (In Cohn, Kryptog. Flora v. Schlesien, 3, 1, 1886, 186.) From stagnant water.

Bacillus saponaceus Miguin. (Bacillus loctis saponacei Weigman and Zirn, Cent. f. Bakt., 15, 1891, 464; Migula, Syst. d. Bakt., 2, 1900, 692.) From soapy milk.

Bacillus suprogenes Chester. (Bacillus suprogenes vini VI Kramer, Bakteriol. Landwirtsch., 1890, 139; Chester, Man. Determ Bact., 1901, 289.) From diseased wine.

Bacillus saprogenes Trovisan. (Bacillus saprogenes I, Rosenbach, Mikroorganismen bei den Wundinsectionskrankheiten des Menschen, Wiesbaden, 1881; Trovisan, I generi ele specie delle Batteriacee, 1889, 17, Bacterium saprogenes Chester, Ann. Rept Del. Col. Agr. Evp. Sta., 9, 1897, 142.) From fecces,

Bacillus surracentedus Dyst. (Dyst., Ann. N. Y. Acad. Sci., 8, 1895, 357; Eacterium sorracentedus (sic) Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 81) From a fresh leaf of the pitcher plant (Surracenta purpura).

Bacillus scarlatinae Jamieson and Edington. (Jamieson and Edington, Brit. Med Jour, 1, 1887, 1285; Bacillus sudaminis Trevisan, I generi e le specie delle Batternacee, 1889, 15) From the skin of scarlet fevor natients

Bacillus scoticus Migula (Bacillus der Grouse-disease, Klein, Cent. 1. Bakt., 6, 1889, 36 and 593; ibid, 7, 1890, 81; Migula, Syst. d Bakt, 2, 1900, 768; Bacillus tetraonis Chester, Man. Determ. Bact., 1901, 221.) The cause of a disease of grouse (Lagopus seoticus) in England and Scotland.

Bacillus secundus Trevisan (Bacillus II, Leube, Arch. f. path. Anat., 100, 1885, 000; Trevisan, I generi e le specie delle Battenacce, 1889, 16.) From urine.

Bacillus secundus fullesi Dyar, Opar, Ann. N. Y. Acad. Sci., 8, 1893. 259; Bacterium secundus fullesii (sic) Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897. 62; Bacterium secundus fullesii Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897. 62; Bacterium secundus fullesi Chester, ibid., 143.) Trom air Dyar regarded his organism as identical with Bacillus No. 2 of Fulles (Ztschr. f. Ilyg., 10, 1891, 250) which was from soil Bacillus septicaemiae lophyri Shiperoich. (Shiperovich, Protect, Plants Ukraine, 1025, 41–46; Abs. in Rev. Appl. Fnt., A., 14, 1025, 200.) From larvae of sawflies (Dirprion sertifer).

Bacillus septicaemicus Trevisan (Bacillus of septicemia of man, Kleia, Aliceoorganisms and Disease, 1885, 84; Trevisan, in DeToni and Trevisan, in Saccardo, Sylloge Fungerum, 8, 1889, 945) From blood and infected lymph glands

Bacillus septicus hominis Mironofi. (Mironofi, Cent. f. Gynäkol., 1872, 42; Hacterium septicus hominis Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1887, 143.) From a case of teptic infection of the uterus. Regarded by Chester (Man Determ. Bact., 1801, 143) as a synonym of Pasteurella agrigena Trevisan.

Bacillus septicus resicae Clado. (Bullde la Soc. anatom. de Paris, 1887, 339) From the urine of a person suffering from cystitis

Bacillus sericcus Zimmermana (Bakt. unserer Trink- u. Nutzwässer, Chemnitz, 2, 1894, 52.) From water.

Bactlus serratus Migula. (Bacillus No. 14, Pansini, Arch f. path Anat, 122, 1890, 449; Migula, Syst. d. Bakt, 2, 1900, 658.) From sputum.

Bacillus selosus Migula (Bacillus No XVIII, Adametz, Landwirtsch, Jahrb, 18, 1889, 250; Migula, Syst. d. Bakt, 2, 1900, 812) From cheese.

Bacıllus ulberschmidii Chester (Bacıllus der Fleischvergitung, Suberschmidt, Correspondenz-Blatt f Schweizer Aerzte, 1896, No 8; Chester, Man Determ. Bact, 1991, 212.) From poison ous meat.

Bacillus simulans Trevisan (Bacille de l'arr a, Babes, in Cornil and Babes, Les Bactérics, 2nd ed., 1886, 149, Trevisan, I generic le specie delle Batteriacee, 1889, 20) From air

Bacillus singularis Losski (Inaug Diss, Dorpat, 1893, 45) From garden soil.

Bacillus siliculosus Kern. (Arb bakt Inst. Karlsruhe, 1, Heft 4, 1896, 423) From the stomachs and intestines of birds.

Bacillos sordidus Dyar (Dyar, Ann N. Y. Acad Sci, 8, 1805, 379, Bacterum sordidus Chester, Ann Rept Del Col Agr. Exp. Sta., 9, 1897, 79) Culture received by Dyar as Micrococcus sordidus from Krill's laboratory

Bacillus sordidus Kern. (Arb Bakt Inst. Karlsruhe, 1, Heft 4, 1896, 396) From the stomach of a bird.

Bacillus spermophilinus Issatehenho (En aus Zieselmäusen ausgeschiedener Baeillus, Meresenkonsky, Cent I Bakt, 17, 1895, 742, Issatchenko, Scripta Botanica Hort Univ. Imp Petropolitanes, Fasc. XV, 1897, quoted from Migula, Syst. d. Bakt., 2, 1900, 618) Papmarrum Prom ground squirrefs (Spermophilius musicus)

Bacillus spirans Weiss (Arb bakt Inst. Karlsruhc, 2, Heft 3, 1902, 222) From bean infusions.

Bacillus spumosus Zimmermann (Bakt. unserer Trink- u. Nutzwässer, Chemnitz, 2, 1891, 23) From water Bacillus spumosus Pansins (Arch

i. path. Anat , 122, 1890, 448) From sputum.

Bacillus strassmanni Trevisan. (Bacillus albus cadqueris Strassmann and Strecker, Zischr f. Medicinalbeamte, 1883; Trevisan, I generi e le specie delle Batteriacee, 1889, 17, Bacterium albus cadareris Chester, Ann. Rept Del Col. Agr. Erp Sta., 9, 1897, 102; Bacillus cadareris Migula, Syst d. Bakt, 2, 1900, 616) From the blood of an infant

Bacillus striatus Doyen (Bacillus urinae striatus Doyen, Jour. d connaiss. médie, 1889, 107, Doyen, ibid, 108) From urine.

Bacillus streatus albus von Besser. (Ziegler's Beitrige, 4, 1889, 331) Found in normal nasal mucus

Bacillus striatus flavus von Besser. (Ziegler's Beitrage, 4, 1889, 331; Bacterium striatus flavus Chester, Ann Rept. Del Col Agr. Exp Sta , 9, 1897, 111.) From pasal mucus. Rare.

Bacillus strumitidis Migula (Bacillus strumits a, Tavel, Ueber die Actiologie der Strumitis, Basel, 1892, SI, Migula, Syst. d Bakt, 2, 1000, 741) From a case of strumitis

Bacillus strumits Tavel. (Tavel, 1889, see Viquerat, Ann de Mierographie, 2, 1889-1890, 228) From acute catarrhal strumits

Bacillus subcoccoideus Migula. (Bacillus aquantis sulcatus III, Weichselbaum, Das osterreichische Samitatenesen, 1889, No. 14-23, Migula, Syst d Bakt., 2, 1990, 732) From water

Bocillas subflauns Zimmermann. (Zimmermann, Bakt. unserer Trink. u. Nutsnasser, Chemnutz, J., 1800, 62, Bacterum subflauns Chester, Ann. Rept. Del Col Agr. Evp Stn., 9, 1807, 109). From water According to Chester (Man Determ Bact, 1901, 253). Bacillus flarescent Pohl is identical with this soccies

Bacillas subgestricus White (U. S. Dept Agr Bur Ent, Tech Bul. 14, 1996, 23) From intestinal contents of honey bee (Apis metil/era). While this does not appear to be the same as Bacillas gastricus Pord (see Steinhaus, Bucteria Associated Extracellusirly with Insects and Techs. Minneapolis, 1912, 85), it may have been desembed by some

previous author as White does not indicate that he regards it as new.

Bacillus subochraceus Dynr. (Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 358; Bacterium subochraceus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 110.) From air.

Bacillus subrubiginosus Migula. (Braunroter Bacillus, Maschek, Bakt. Untersuch. d. Leitmeritzer Trinkwasser, Leitmeritz, 1887, Migula, Syst. d. Bakt., 2, 1900, 836.) From water.

Bacillus subsulcatus Migula. (Bacillus aquatilis sulcatus II, Weichselbaum, Das österreichische Sanitatswesen, 1889, No. 14-23; Migula, Syst. d. Bakt., 2,

1900, 732.) From water

Bacillus sulcatus Chester. (Bacillus sulcatus liquefaciens Kruse, in Flügge, Die Mikroorgansmen, 3 Aufl , 8, 1896, 318; Bacterium sulcatus liquefaciens Chester, Ann Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 07; Chester, Man. Determ. Bact , 1901, 213; not Bacillus sulcatus Migula, Syst. d. Bakt , 2, 1900, 731.) From water.

Bacillus sulcatus Migula (Bacillus aquatilis sulcatus I, Weichselbaum, Das österreichische Sanitatswesen, 1889, No. 14-23; Migula, Syst d Bakt, 2, 1900,

731.) From water

Bacillus sulfhydrogenus Miquel. (Ann. de Micrographie, 1, 1888-1889,

369 ) From sewage.

Bacillus tardissimus DeToni and Trevisan (Bacillus fluidificans tardissimus Maggiora, Giorn Soc ital. d'Igene, 11, 1889, 317, DeToni and Trevisan, in Saceardo, Sylloge Fungorum, 8, 1839, 967) From the shi of the human foot

Bacillus fartrieus Grimbert and Fiquet. (Jour. Pharm. et de Chim, 6 Scr., 7, 1898, 97; Compt rend. Soc. Baol, 49, 1897, 962) Decomposes d-tartrates. Probably identical with Aerobecter cloacae (Vaughn et al., Jour. Bact, 52, 1946, 324).

Bacillus telmatis Trevisan (Bacillus saprogenes 2, Rosenbach, Mikroorganismen bei den Vundinfectionskrankheiten des Menschen, Wiesbaden, 1884; Trevisan, I generi e le specie delle Batteriacce, 1889, 14) From perspiration of feet.

Bacillus tenuis Doyen. (Bacillus ursaae lenuis Doyen, Jour. d. connaiss. médic., 1889, 107; Doyen, joid., 108; not Bacillus tenuis Migula, Syst. d. Bakt., 2, 1900, 587; Bacillus tenuitus Trevisan, in DeToni and Trevisan, in DeToni and Trevisan, fis Saccardo, Sylloge Fungarum, &, 1889, 948.) From urine

Bacillus tenus apis White. (Jour. Path. and Bact., 24, 1921, 72.) From intesting of bee.

Bacillus terrigenus Frank. (Berichte deutsch. botan. Gesellsch., 4, 1886, 000.) From soil.

Bacillus thermophilus Miquel. (Miquel, Ann. de Microgr., J., 1885-1899, f. not Bacillus thermophilus Chester, Man. Determ. Bact., 1901, 205; not Bacillus thermophilus Bergey et al., Manual, 1st ed., 1923, 315.) From water, sewagr, soil, etc.

Bacillus theta Dyar. (Ann. N. Y. Acad. Sci., 8, 1895, 375; Bacterium thela Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 144.) From air.

Bocillus tingens Eckstein. (Zischr. f. Forst. v. Jagdwesen, 28, 1891, 10.) From dead larvae of Orgyia pudibunda.

Bacillus toluolicum Tausson. (Planta, 7, 1929, 735.) From soil. Oxidizes toluene.

Bacillus toxigenus Chester. (Bacillus of 1ce cream poisoning, Vaugha and Perkins, Arch. f. Hyg., 27, 1896, 308; Chester, Man. Determ. Bact., 1901, 208) From poisonous ice cream

Bacillus trambustii Kruse. (Trambusts and Galeotti, Cent. f. Bakt., 11, 1892, 717; Kruse, in Flügge, Die Mikroorganismen, 3 Aufi., 2, 1896, 319; Bacterium trambusti Chester, Ann Rept. Del. Col Agr. Exp. Sta., 9, 1897, 97.) From water.

Bacillus tremaergasius Trevisan. (Bacille du mucus intestinal normal d, Babes, in Cortnil and Babes, Les Batérics, 2nd ed., 1886, 153; Trevisan, I generie le specie delle Batteriace, 1889, 165) From normal intestinal mucus

Bacıllus trimethylamin Beijerinck. (Bot. Zeitung, 46, 1883, 726.)

Bacillus truttae Mersch (Quoted from Lehmann and Neumann, Bakt Diag., 7 Aufl., 2, 1927, 481.) Closely related to Bacterium calmonicida Lehmann and Neumann

Bacillus tumidus Chester. (Anaerobe Bacillus I, Sanfelice, Ztschr. f Hyg, 14, 1893, 268; Chester, Man Determ Bact, 1901, 265.) From putrefying flesh Striet anaerobe.

Bacıllus uffreduzzii Trevisan terio della setticemia salivare nei conigli, Bordom Uffreduzzi and Di-Matter, Arch per le scienze med , 10, 1886, Trevisan, see DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 951) From normal human saliva.

Bacillus ulna Cohn (Beitr z Brol d. Pflanz., 1, Heft 2, 1872, 177 ) From

water, air, etc.

Bacillus umbilicatus Zimmermann (Bakt, unserer Trink- u Nutzwasser, Chemnitz, g, 1894, 6) From nater

Bacillus urinae Migula. (Ein Harnbacterium, Karplus, Arch f path. Anat , 131, 1893, 211; Migula, Syst d. Bakt , 2, 1900, 739.) From urine

Bacillus utpadeli Trevisan. (Bacillus aus Zuischendeckenfüllung, Utpadel, Arch. f. Hyg., 6, 1887, 359, Trevison, I generi e le specie delle Batteriacce, 1889, 15.) From the intestine

Bacillus vacuolatus Dyar (Dyar. Ann. N. Y. Acad. Sci., 8, 1895, 357, Bac terium racuolatus Chester, Ann Rept Del. Col Agr. Exp Sta., 9, 1897, 81) From a trap of the carnivorous water plant, Utricularia vulgaris

Bacillus tegetus Kern (Arb bakt Inst. Karlsruhe, 1, Heft 4, 1896, 399) From the atomach and intestines of birds.

Bacillus relox Kern (Arb bakt Inst Karlsruhe, f, Heft 4, 1896, 405 ) From the stomach and intestines of birds Bacillus venenosus brevis Vaughan

(Amer. Jour. Med. Sci., 104, 1892, 192; Bacterium tenenosus and Bactersum renenosus brevis Chester, Ann. Rept. Del. Col Agr. Exp. Sta., 9, 1897, 76 ) From water.

Bacillus tenenosus Chester. (Bacillus venenosus unusibilis Vaughan, Amer. Jour Med. Sci , 104, 1892, 192, Baclerium zenenosus invisibilis Chester, Ann Rept Del Col Agr Eap Sta., 9, 1897, 76, Chester, Man Determ Bact , 1901, 224, not Bacillus tenenosus Vaughan, Amer. Jour Med Sci . 104, 1892, 191.) From water

Bacıllus renenosus Isquefactens Vaughan (Amer. Jour Med. Sei , 104, 1892, 193 ) From water.

Bacillus ventricosus Weiss (Weiss, Arb bakt. Inst Karlsruhe, 2, Heft 3, 1902, 233, not Bacillus tentricosus Bredemann and Heigener, Cent f Bakt, II Abt , 95, 1935, 102 ) From vegetable infusions

Bacıllus ventrıculı Raczynski (Diss. milit. medic Acad Petropolitanae Ruteniae, 1888, abst in Cent f Bakt, 6, 1889, 113) From the stomach of a dog

Bacillus termiculosus Zimmermann (Zimmermann, Bakt unserer Trink- u Nutznasser, Chemnitz, 1, 1890, 40. Bacterium rermiculosus Chester, Ann Rept Del Col Agr Evp Sta , 0, 1897, 99) From nater

Bacillus versatilis DeToni and Trevisan (Bacallus A, Maggiora, Giorn Soc ital d'Igiene, 11, 1889, 339, DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 968) From the skin of the human foot and from air

Bacillus tesiculiferus Migula (Bacıllus strumitis \$, Tavel, Ueber die Aetio]. ogie der Strumitis, 1892, 110, Migula, Syst d Bakt , 2, 1900, 741 ) From a case of strumates

Bacillus vialis Hansgirg (Oesterr. bot Ztschr, 1888, 6) From roadside soil from near Prague

Bacillus viator Trevisan (Bacille de Pair c, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 150, Trevisan, I genera e le specie delle Batteriacce. 1889, 20 ) From air

Bacillus villosus Migula. (Bacillus aquatilis villosus Tataroff, Inaug. Diss., Dorpat, 1891, 47; Migula, Syst. d. Bakt., 2, 1900, 828; not Bacillus villosus Keek, Inaug. Diss., Dorpat, 1890, 47.) From water.

Bacillus vinicola Migula. (Bacillus saprogenes vini II, Kramer, Die Bakterien in ihren Beziehungen zur Landwirtschaft, 2, 1892, 136; Migula, Byst. d. Bakt., 2, 1900, 685.) From wine.

Bacillus vinsperda Migula. (Bacillus saprogenes vini I, Kramer, Die Bakterien in ihren Baziehungen zur Landwirtschaft, 2, 1892, 135; Migula, Syst. d. Bakt., 2, 1900, 684.) From wine.

Bacillus virens van Tiegliem. (Bull. Soc. bot. France, 27, 1880, 175.) From aquatic plants.

Bacillus viridans Zimmermann. (Bakt. unserer Trink. u. Nutzwässer, Chemnitz, 2, 1894, 22.) From water.

Hacillus viridescens non-liquefactens Ravenel. (Ravenel, Mem. Nat. Acad. Sci., 8, 1806, 14; Bacterium virdescens non-liquefactens Chester, Ann. Rept. Del. Col. Agr. Dap. Sta., 9, 1897, 72 and 123.) I rom seil.

Bacillus vulpinus von Iterson. (Cent. f. Bakt., II Abt., 12, 1901, 111.) From fresh garden soil, canal water.

Bacillus wards: Chester. (Gas- and taint-producing bacillus in cheese curd, Moore and Ward, Cornell Univ. Agr. Expt. Sta., Bull. 158, 1899, 221-227, Chester, Man. Determ Bact., 1901, 206.) From tainted, gassy cheese curd and from milk drawn directly from the udder Presumably this was a coliform orwanism.

Bacillus weckers Trevtsan (Bacillus der Jequirity-Ophthalmie, de Wecker, 1882; see Flügge, Die Mikroorganismen, 2 Ausl., 1886, 279, Trevisan, 1 generi e le specie delle Batteriacee, 1889, 17.) From mfusions of jequirity seed (Abri precatoru)

Bacillus wesenbergi: Chester (Bacillus der Fleisehvergiftung, Wesenberg, Ztschr. f. Hyg., 28, 1859, 484; Chester, Man Determ. Bact., 1901, 247; not Bacillus wesenberg Castellani.) From meat which caused a meat poisaning outbreak. Closely related to Proteus rulgaris Hauser.

Bacillus usichmanni Trevisan. (Goldgeber Wasserbacillus, Adametz and Wichmann, Mitth. Oest. Vers. Stat. f. Brauerei u. Mälz., 1, 1888, 49; Trevisan, I generi e le specie delle Batteriscee, 1880, 19; Bacillus chryseus Migula, Syst. d. Bakt., 2, 1900, 833.) From water.

Bacilluszeta Dyar. (Dyar, Ann. N. Y Acad. Sci., 8, 1895, 369; Bacterium zela Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 114.) From air.

Bacillus zonatus Migula. (Bacillus No. 15, Pansini, Arch. f. path. Anat, 122, 1890, 450; Migula, Syst. d. Bakt, 2,

1900, 658.) From sputum.

Bacillus zörhendörferi Migula. (Bacillus oogenes hydrosulfureus 4, Zörkendörfer, Arch. f. Hyg., 10, 1893, 385; Migula, Kyst. d. Bakt., 2, 1900, 696.) From
hens' eggs.

Bacillus zymoscus (Leube) Trevisan (Coccobacillus zymogenes Leube, Arch. f. path. Anat., 1885; Trevisan, I generi e le specie delle Batteriace, 1889, 16) From Iermenting infusions.

Bacterium acidi propionies Weigmana (Weigmann, quoted from Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 76; Plocamobacterium acidi propionici Pribram, idam.)

Bacterum aeris Migula. (Bacillus aeris minutissimus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1895, 441; Bacterum aeris minutissimus Chester, Ann. Rept. Del. Col. Agr Eap. Sta., 9, 1897, 109, Migula, Syst. d. Bakt., 2, 1900, 445, Bacterium aeris-minutissimum Chester, Man Determ. Bact., 1901, 168.) From air.

Bacterium aerogenes I and II Miller. (Miller, Deutsche med. Wochnschr., 12, 1886, 119; see Miller, Die Mikroorganismen der Mundhohle, Leipzig, 1889, 261

and Trevisan, in Saccardo, bylloge Fungerum, 8, 1889, 952.) From the digestive tract of man Bacterium agreste Lohnis (Löhnis, Cent f. Bakt., I Abt., Orig , 40, 1906, 177; Bacillus agrestis de Rossi, Microbiol agraria e technica, Torino, 1927, 828, not Bacillus agrestis Werner, Cent. f Bakt., II Abt., 87, 1933, 468) From soil

Bacterium agrigenum (Trevisan) Migula. (Bacillus septicus agrigenum Flugge, Die Mikroorganismen, 2 Aufi, 1880, 257; Pasteurella agrigena Trevisan, 1 generi e le specie delle Battenacee, 1889, 21; Bacterium septicus agrigenus Chester, Ann Rept. Del Col Agr Exp Sta., 8, 1897, 85; Migula, Syst d Bakt, 2, 1900, 372; Bacterium septicum Chester, Man, Determ. Bact, 1901, 143) From Man, Determ. Bact, 1901, 143) From

Bacterium album Migula (Weisser Bacillus, Tataroff, Inaug. Diss., Dorpat, 1801, 35; Migula, Syst. d. Bakt., 2, 1900, 419.) From water.

Bacterium algeriense Migula (Gayon and Dubourg, Ann Inst Past, 8, 1894, 108, Migula, Syst d. Bakt, 2, 1900, 513) Isolated in Algiers from wine where it causes a mannitol fermentation

Bacterium alsphaticum Tausz and Peter. (Cent. f. Bakt, H Abt, 49, 1919, 505) From garden soil

Bacterium aliphaticum liquefaciens Tausz and Peter. (Cent f Rakt, 11 Abt., 49, 1919, 505.) From garden soil

Ractersum altantoides (Klein) Chester (Bacillus allantoides Klein, Cent f Bakt., 6, 1889, 383, Chester, Ann Rept Del. Col. Agr. Exp. Sta., 9, 1897, 103) Isolated as a culture contamination

Bacterium alutaccum Migula (Goldgelber chagrinierter Bacillus, Tataroff, Inaug. Diss., Dorput, 1891, 62, Migula, Syst. d. Bakt., 2, 1900, 461) I'rom water.

Bacterium ambiguum Chester (Chester, Ann. Rept Del. Col Agr Fap Sta. 11, 1900, 59, not Bacterium ambiguus Chester, ibid, 9, 1897, 71, not Bacterium ambiguum Levine, Abst. Riet. 4, 1920, 15) From soil.

Bacterium amforeti Issitchenko (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian), Petrograd, 1914, 237.) From sea water.

Bacterium anaerobium Migula, (Fuchs, Inaug. Diss., Greifswald, 1890, Migula, Syst. d Bakt, 2, 1900, 388.) Obligate anaerobe. Pyogenic Possibly a spore-former

Bacterum anguillarum (Canestrini) Migula (Bacillus anguillarum Canes trini, Atti d R Instituto Veneto di Scienze, Ser 7, 1802-93, Migula, Syst. d Bakt, 2, 1900, 442) From diseased relis m the valleys of Comacchio

Bacterium angustum Migula (Lembke, Arcli f. Hyg, 25, 1896, 305, Migula, Syst d Bakt 2, 1900, 474) From frees

Bacterum aphhosum (Kruse) Chester. (Bacilles der Mundseunch des Menschen, Siegel, Deutsch med Wochnschr., 1801, No. 49, 1328, Bactilus aphthesus Kruse, in Fluggs, Die Mikroorganismen, 3 Aufl. 2, 1896, 427, Chester, Ann Rept Del Col Agr Evp Sta. 9, 1897, 85) From the liver and kidneys of cattle affected with foot and mouth discense.

Bacterium apis No 1, No. 2 and No. 3, Metalnikov and Kostritsky (Compt. rend Soc Biol, Paris, 114, 1933, 1291) From diseased bees (Apis mellifera)

Bacterium aquatile aurantiacum von Rigler (llyg Rund, 12, 1902, 40) From bottled mineral waters

Bactersum aquatile citreum von Rigler, (Hig Rund., 12, 1902, 481) From bottled mineral waters.

Bacterium aquatile debile von Rigler. (Hyg. Rund , 12, 1902, 481) From bottled mineral waters

Bacterium aquatile flatum von Rigler. (Hyg. Rund., 12, 1902, 480.) From bottled mineral waters

Bacterium aquatile tuteum von Rigler. (Hyg. Rund, 12, 1902, 480.) From bottled mineral waters

Batterum arborescens non liquefaciens von Rigfer (Hyg. Rund., 12, 1932, 470, not. Batterum arborescens non-liquefaciens Chester, Ann. Rept. Del. Col. Agr., Evp. Sta., 9, 1807, 103) From bottled mineral waters.

Hacterium gretieum Issatchenko. (Re-

cherches sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 148.) From sea water.

Bacterium arthritidis Migula. (Schüller, Berliner klm. Wochnschr., 1893, No. 36; Bacüllus arthritidis chronicae Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 287; Migula, Syst. d. Bakt., 2, 1900, 443.) From a case of chronic arthritis.

Bacterium asportferum Migula. (Flugge, Ztschr. f. Hyg., 17, 1894, 299, Anaērobier No. II, Kruse, in Flügge, Die Mikroorganismen, 3 Ausl., 2, 1896, 251; Migula, Syst. d. Bakt., 2, 1990, 446.) From milk.

Bacterium aurantii (Viron) Migula. (Bactllus aurantii Viron, Compt. rend. Acad. Sci., Paris, 114, 1802, 179, Migula, Syst. d. Bakt., 2, 1900, 512.)

Bacterum aurantum-roseum Honing (Honing, Cent f. Bakt., II Abt., 37, 1913, 373; Plocamobacterum aurantium Pribram, Klassifikation der Schizomyeeten, Lelpzig und Wien, 1933, 77.) From fermenting tobacco.

Bacterium aurescens (Frankland and Frankland) Miguila. (Bacillus aurescens Frankland and Frankland, Philos. Trans. Royal Soc of London, 178, 1887, B, 271; not Bacillus aurescens Ravenel, Mem. Nat. Acad. Sci., 8, 1896, 8, Miguila, Syst. d. Bakt., 2, 1900, 466) From air

Bacterium aureum (Frankland and Frankland) Migula. (Bacillus aureus Frankland and Frankland, Philos Trans. Royal Soc. of London, 178, 1887, B, 272; Migula, Syst. d. Bakt, 2, 1900, 480.) From air.

Bacterium aureum (Adametz) Chester. (Bacillus aureus Adametz, quoted from Sternberg, Man of Bact, 1893, 621, not Bactllus aureus Frankland and Frankland, Philos Trans. Roy. Soc. London, 178, 1857, B, 272, not Bacillus aureus Pansini, Arch. f. path. Anat., 122, 1890, 336; Bacillus aureo-flavus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 310; Bacterium aureo flavus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 2897, 109; Chester, ibid., 129; not Bac-

terium aureum Migula, Syst. d. Bakt., 2, 1900, 480; Bacilius flavus Chester, Man, Determ. Back., 1901, 255; not Bacilius flavus Fuhrmann, Cent. f. Bakt., 11 Abt., 18, 1907, 117; not Bacilius flavus Bergey et al., Manual, 1st ed., 1923, 286.) From water (Adametz); from the skin in cases of exerms (Tommasoli, Monats. f. prakt. Dermatol., 9, 1

Bacterium avium Chester. (Bacillus of roup in fowls, Moore, U. S. Dept. Agr. Bur. Animal Industry, Bull. 8, 1895; Chester, Man. Determ. Bact., 1901, 133) From exudate of fowls in roup or diphtheria.

Bacterium babesii Migula. (Bacillus septicus acuminatus Babes, Bakteriol. ogische Untersuchungen der septischen Prozesse des Kindesalters, Leipzig, 1889; see Eisenberg, Bakt. Diag., 3 Aufl., 1891, 327; Bacterium septicus acuminatus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 66; Migula, Syst. d. Bakt., 2, 1900, 507; Bacterium acuminatum Chester, Man. Determ. Bact., 1901, 110.) From blood and organs of a new-born infant with septicemia.

Bacterium balbianii Billet. (Billet, Compt. rend. Acad. Sci., Paris, 107, 1839, 423; also in Bull. Sci. de la France et de la Belgique, £1, 1890, 103; Bacillus balbianii Trevisan, I generi e le specie delle Batteriacce, 1859, 17.) From sea water.

Bacterium barentsianum Issatchenko. (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 155.) From sea water.

Bacterium berjerinchi Issatchenko. (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 157.) From sea water.

Bacterum benzoli a and b Wagner. (Ztsehr. f. Garungphysiol., 4, 1914, 289.) From soil. Utilize benzene and certain benzene derivatives.

Bacterium besseri Migula. (Besser, Cent f Bakt., 15, 1893, 590; Migula, Syst. d. Bakt., 2, 1900, 503.) From smallpox.

Bacterium betae viscosum Panek. (Bull. Acad. Sci. Cracovie, 1, 1905, 5.) From fermenting beets Reported to liquely agar-gelatin (Biernacki, Cent f Bakt., 29, 1911, 166) Stanier (Jour Bact., 42, 1941, 548) thinks this was a heterofermentative Lactobaculus

Bacterium bossonis Chester (Bacillus uber eine neue Infektionskrank des Rindviehs, Bosso, Cent f. Bakt, 22, 1897, 537 and 23, 1898, 318, Chester, Man Determ. Bact, 1901, 153) Associated with an infectious disease of eattle

Bacterium boutrauxii (Trevisan) De-Toni and Trevisan, (Alicroeccus capable d'acétifer l'alcohol, Boutroux, Am. Inst Past., 2, 1888, 209, Bacillus boutrouxi: Trevisan, I generi e le specie delle Batteriace, 1889, 16, DeToni and Trevisan, in Sacardo, Sylloge Pungorum, 8, 1889, 1021) From alcoholic infusions.

Bacterium borrs Migula (Preumoboaillus liquelacens bors Along, Compt rend. Acad. Sci. Praris, 29, 18—, 199 and 116, Bacillus menumenues liquelacens Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 283, Bacterium meumonitus liquelacens Chesteri, Ann Rept Del. Col. Agr. Evp. Sta., 9, 1897, 99, Migula, Syst. d Bakt., 2, 1909, 442, Bacterium meumonicum Chester, Man Determ. Bact, 1901, 185 From the evudate of lung plague in cattle A Cram-positive occeus-like bacterium

Bacterium brassicae Conrad (Bacterium brassicae acidae Lehmann and Conrad, in Lehmann and Neumann, Bakt. Diag, 1 Aud., 2, 1896, 232, Conrad, Arch. f. Hyg., 29, 1897, 82, not Bacterium brassicae Welmer, Cenf f Bakt., II Abt., 10, 1903, 628, not Bacterium brassicae Migula, Syst d Dakt., 2, 1000, 296 (Bacillus brassicae Pommer, Mitt. botan. Inst. Grav. 1, 1880, 63). Bacillus brassicae Migula, bc. cet., 737 ) From saueckratut.

Bacterium breitfussi Issatelienko (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 152) From sea water

Bacterium brevissimum Weiss. (Arb

bakt Inst. Karlsruhe, 2, Heft 3, 1902, 227.) From vegetable infusions.

Bacterium brunncoffatum (Dyar) Chester (Bacillus brunncoffatus Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 362, Chester, Ann Rept. Del Col. Agr. Exp. Sta., 9, 1897, 112) Culture received from Král's laboratory as Micrococcus brunneus

Bacterium bullosum Migula. (Bacillus No IS, Pansiai, Arch. f pathol Anat. u. Physiol., 122, 1890, 451, Migula, Syst. d Bakt, 2, 1900, 415) From feees.

Bacterium cadaieris (Stemberg) Cliester (Bacillus cadaieris Stemberg, Man, of Bact, 1893, 492, Chester, Ann, Rept, Del Col Agr. Exp Sta, 9, 1807, 120) From hver and kidneys of yellow fever cadavers. Anaerobe

Bacterum canalis Migula (kapseltragender Kanalbacillus, Mora, Zischr f Hyg., 4, 1888, 52, Bacillus canalis capsulatus Sternberg, Man of Bact., 1803, 446, Bacterum canalis capsulatus Ches ter, Ann Rept Del Col Agr Exp Sta., 9, 1807, 130, Mugula, Syst d. Bakt., 2, 1900, 351) From sownge

Batterium canalis parium (Sternberg) Chester (Bacillus canalis parius Sternberg, Man of Bact, 1893, 470, Chester, Ann. Rept Del Col Agr Exp Sta., 9, 1897, 130) Obtained by Mori (1888) from seuage

Bocterium corneum (Kruse) Chester. (Hesschlarbiger Bacillus, Tils, 2tselt., f lly, 9, 1800, 291, Bacillus carneclor Frankland and Frankland, Aleronganisms of Water, 1891, 477; Bacillus carneus Kruse, in Flügge, Die Shikrorganismen 3 Auft. 2, 1802, 301, Chester, Inn Rept Del Col Agr Fxp Sta, 9, 1897, 113) From water

Bacterium carnosum Kern. (Arb. bakt lust Karlsruhe, I, Heft 4, 1896, 448) From the intestines of birds.

Bacterium cartilogineum (Olsen-Sopp)
Buchanan and Ilammer (Bacillus cartilogineus Olsen-Sopp, Cent f. Bakt,
II Abt, 55, 1912, 49, Buchanan and
Ilammer, Iona Str Agr Lyn, Sta.,
Res Bull 22, 1915, 271) I'rom slimy
or ropy sour milk called false taette

Bacterium cascicola Migula. (Bacillus No. XII, Adametz, Landw. Jahrb., 18, 1889, 215; Migula, Syst. d. Bakt., 2, 1900, 475.) From cheese.

Bacterium castellum Henrici. (Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1891,

38.) From cheese.

Bacterum catenula Dujardin. (Dujardin, Ilist, natur. des 200ph., 1811; Bacillus catenula Trevisan, I generi e le specie delle Batteriacee, 1859, 18; not Bacillus catenula Migula, Syst. d. Bakt., 2, 1900, 588.) Prom rice paddies and swamps.

Bacterium carotum Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 449.) From the intestines of birds.

Bacterium caternae Migula. (Bactilus caternae minutissimus Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 410; Pfeiffer und Beck, Deutseh. med. Wochnsehr., 1892, No. 21; Migula, Syst. d. Bakt., 2, 1900, 509.) From human tubereulosis.

Bacterium cavaa fortuitum (Sternberg) Chester. (Bacillus cavaa fortuitus Sternberg, Man. of Bact., 1893, 650; Chester, Ann. Rept Del. Col. Agr. Exp. Sta., 0, 1897, 74) From the liver of a yellow fever cadaver.

Bacterium caucida haraniensis (Sternberg) Chester. (Bacillus caricida havaniensis Sternberg, Man of Bact, 1893, 425; Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 74.) From the intestine of a yellow fever eadaver.

Bacterium centricum Migula (Huber, Armin, Archi f. pathol. Anat u. Physiol., 134, 1893, 216; Migula, Syst d. Bakt., \$, 1900, 390; not Bacterium concentricum, a typographical error, see Migula, tod., page v.) Trom a case of cystitis.

Bacterium cerinum Henrici (Arb bakt. Inst. Karlsruhe, 1, Heft 1, 1891,

50.) From cheese.

Bacterium chlorinum Engelmann (Bot. Zeitung, 1882, 324.) Green pigment.

Bacterium chologenes (Kruse) Chester (Colonbacillus, Stern, Deutsche med. Woebnschr., 1893, 613; Bacillus chologenes Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1893, 374; Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 69.) From a case of purulent meningitis.

Bacterium chryseum Migula. (Bacillus nova species 11, Freund, Inaug. Diss., Erlangen, 1893, 37; Migula, Syst. d. Bakt., 2, 1990, 477.) Chromogenie bacterium from the mouth cavity.

Bacterium chrysogloea Zopf. (Zopf, in Overbeek, Nova Acta d, kais. Leop. Carol. Akad. d, Naturf., 55, 1891, No. 7; Bacillus chrysogloia (sic) Zimmermann, Bakt. unserer Trink- u. Nutzwässer, 2, 1891, 12.) From water.

Bacterium citrcum (Irankland and Frankland) Migula. (Bactilus citrus Frankland and Frankland, Philos. Trans. Royal Soc. of London, 178, 1887, B, 272; Migula, Syst. d. Bakt., 2, 1900, 459.) Trom air.

Batterium cols apium Serbinow. (Jour. Microbiol. Petrograd., 2, 1915, 19.) From honey bees (Apis mellifera)

Bacterium coli similis (Sternberg)
Chester. (Bacillus coli similis Sternberg, Man. of Bact., 1893, 650; Chester, Ann. Rept. Del. Col. Agr. Exp Sta, θ, 1897, 132.) From a human liver.

Bacterium colloideum Migula. (Bacterium butyri colloideum Lafar, Arch. f. Hyg., 15, 1891, 17; Migula, Syst. d. Bakt., 2, 1900, 409.) From butter.

Bacterium comes Bersteyn. (Arb. bakt. Inst. Karlsruhe, 5, 1903, 93.)

From soil.

Bacterium compactum (Kruse) Migula. (Bacillus compactus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl, 2, 1896, 353; Migula, Syst d Bakt., 2, 1900, 433) From air.

Bacterium concentricum Kern. (Arb bakt Inst. Karlsruhe, 1, Heft 4, 1896, 437.) From the intestines of birds.

Bacterium conjunctivitidis (Kruse) Migula. (Koch, Berichte aus Aegypten an den preuss. Staatsminister des Innern; see Arb. a d. kaiser! Gesundheitsamte, 5, 1887; Kartulis, Cent. Bakt., 1, 1887, 289, Bacillus aegyptus

Trevisan, I generi e le specie delle Batteriacee, 1889, 13; Bacillus conjunctivitidis Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 440, Bacterium conjunctivitis Chester, Ann Rept Del. Col. Agr. Exp. Sta , 9, 1897, 67, Migula, Syst. d. Bakt., 2, 1900, 509, not Bacterium conjunctivitidis Chester, Man. Determ. Bact., 1901, 120, Bactersum aegyptium Chester, ibid , 121.) Associated with conjunctival catarrh in Egypt,

Bacterium corticale (Haenlein) Migula (Bacillus corticalis Haenlein, Deutsch. Gerberzeitung, 1894, No. 18-34, Migula, Syst. d. Bakt., 2, 1900, 449 ) Found on pine bark: in acid dveing-liquor Bacterium crenatum Weiss (Arb

bakt Inst. Karlsruhe, 2, Heft 3, 1902, 221.) From fermenting malt.

Bacterium cristalliferum Gicklhorn (Cent. f. Bakt., II Abt . 50, 1920, 420) A sulfur bacterium from soil. See Manual, 5th ed , 1939, 86 for a description of this organism.

Bactersum cutscularis (Tils) Chester. (Bacillus euticularis Tils, Ztschr f. Hyg., 9, 1890, 293, Chester, Ann Rept Del. Col. Agr Exp. Sta., 9, 1897, 105)

From water.

Bacterium debile Berstyn. (Arb bakt Inst. Karlsruhe, 5, 1903, 96) From soil. Bacterium delendae-muscae Roubaud and Descazeaux (Compt. rend. Acad Sci., Paris, 177, 1923, 716) From fly larvae (Stomozys calcutrans and Musca domestica).

Bacterium deliense Honing (Cent f. Bakt., 11 Abt , 57, 1913, 377 ) From tobaeco plants in Sumatra

Bacterium diatrypelicum Migula (Bacillus diatrypeticus case: Baumann, Landwirtsch. Versuchsstationen, 42, 1893, 181; Migula, Syst d. Bakt , 2, 1900, 401) From cheese.

Bacterium enchetus Chrenberg (Ehrenberg, Abhandl d. Akad. d Wissensch. zu Berlin, 1830, 61, Bacillus enchelys Trevisan, I genera e le specie delle Batteriacce, 1889, 18 ) From water.

Baeterium endocarditidis Migula. (Bacıllus endocarditidis cansulatus Weichselbaum, Beitr, z. pathol, Anat. u z. aligem. Pathol., 4, 1887, 197, Migula. Syst. d Bakt , 2, 1900, 359.) Found in the aorta, the left ventricle, the splicen and kidneys of cadavers.

Bacterium endometritidis (Kruse) Chester. (Bacillus endometritidis Kruse, in Flügge, Die Mikroorganismen, 3 Aufl , 2, 1896, 432; Chester, Ann. Rept. Del, Col. Agr. Exp. Sta , 9, 1897, 88.)

From a liver abscess.

Bacterium endometritis canis Meyer. (Meyer, quoted from Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 77; Plocamobacterium endometritis Pribram, idem ) From a case of endometritis in a dog

Bacterium enterocoliticum Schleifstein and Coleman. (A motile, Gram-negative bacillus, Schleifstein and Coleman, N. Y. State Jour. Med , 59, 1039, 1749; Ann Rept Div. Lab. and Res , N. Y. State Dept. Health for 1913, 56 ) From lesions about the face, from an ulcer in the intestine and from the intestinal contents. Resembles Bacillus lignieri and Pasteurella pseudotubereulosis.

Bactersum erythromyza (Zopf) Migula. (Micrococcus (Staphylococcus) erythromyza Zopf, Ber. d deutschen bot. Gesellsch . 1891, 22; Rhodococcus erythromyza Zopf, loc. cit, Migula, Syst d. Bakt , 2, 1900, 487, Bacillus erythromyra Matzuschita, Bakt. Diag. 1903. 389) Frequently listed as a Micrococcus

Bacterium exanthematicum (Kruse) (Baeille, Babes and Oprescu, Chester Ann Inst. Past , 5, 1891, 273, Bacillus exanthematicus Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 426; Chester, Ann. Rept Del Col. Agr. Exp. Sta , 9, 1897, 87 ) From a case of hemorrhagic septicemia.

Bacterium fausseki Issatehenko. (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian), Petrograd, 1914, 157) From sea water.

Bacterium ferophitum (sic) Migula

(Die ferrophilen Bakterien, Marpmann, Cent. f. Bakt., II Abt., 4, 1898, 21; Migula, Syst. d. Bakt., 2, 1900, 455 and 1053.) Isolated during studies on black discoloration of cheese.

Bacterium finitimum Chester (Bacillus finitimus ruber Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 361; Bacterium finitimus ruber Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 116; Chester, Man. Determ. Bact., 1901, 177.) From air.

Bakterium flareum Wilhelmy. (Arb. bakt Inst. Karlsruhe, 5, 1903, 15.) From meat catract

Bacterium flatocoriaceum (Lisenberg) Chester. (Schwefelgelber Bacillus, Adamets and Wiehnnann, Die Bakterien der Trink- und Nutzwässer, Mitt. Oest. Versuchsstat. f. Brauerer a. Mälz., Wien, Heft 1, 1888, 49; Bacillus flarocoriaceus Eisenberg, Bakt. Diag., 3 Aufl., 1891, 144; Chester, Ann Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 112) From water

Bacterium flarofuscum Migula (No. 9, Lembke, Arch. f. Hyg., 26, 1896, 301; Migula, Syst. d. Bakt., 2, 1900, 179.) From meat.

Bacterium flavum Issatchenko. (Recherehes sur les microbes de l'Océau Glacial Arctique (in Russian) l'etrograd, 1914, 151) From sea water.

Bacterum folicola (Miche) de Jongh (Bacillus folicola Miche, see Jahrh wiss Bot., 53, 1914, 1, thid., 58, 1919, 29; de Jongh, On the Symbiosis of Ardista crispa Thesis, Unv Leiden, 1938, 33) A hacterial symbiont isolated from germinating seeds and embryos

Bacterium freundn Migula. (Bacillus nova species I, Freund, Inaug. Diss., Erlangen, 1893, 31; Migula, Syst. d Bakt., 2, 1990, 472) From the mouth cavity.

Bacterium fungoides (Tschistowitsch) Migula. (Bacillus fungoides Tschistonitsch, Berl klin. Wochnschr, 1892, 513; Migula, Syst. d. Bakt, 2, 1900, 391.) From pus.

Buctersum fuscum (Flugge) Migula.

(Bacillus fuscus FJügge, Die Mikroorganismen, 2 Aufl., 1886, 290; Miguls, Syst. d. Bakt., 2, 1900, 463.) From water.

Baclerium gamma (Dyar) Chester. (Bacillus gamma Dyar, Ann. N. Y. Acad. Sci., 3, 1895, 367; Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 106) From air.

Bacterium gammari Vejdovsky. (Cent. f. Bakt., II Abt., 11, 1901, 481) From sections of a fresh water crustaccan (Gammarus zschokkei). Cells exhibit nuclei, showing milosis.

Bacterium gelechiae No. 1 and No. 2, Metalnikov and Metalnikov. (Compt. rend. Acad. Agr., France, 18, 1993, 2014) From dead and dying larvae of a moth (Gelechia gossypiella).

Bacterium gelechiae No. 5, Metalnikov nud Meng. (Compt. rend. Soc. Biol, Paris, 115, 1933, 170.) From dead larvar of a moth (Gelechia gossypielle). Bacterium gemmiforme Migula. (Lembke, Arch. I. Hyg., 29, 1897, 313; Migula, Syst. d. Bakt., 2, 1909, 301.)

From intestinal contents,
Bocterum gibbosum Weiss. (Arb.
bakt. Inst. Karlsruhe, 2, Heft 3, 1902,
239.) From fermenting beets and malt
Bacterium ginginae pyogenes Miller.

Bacterium gingirae pyogenes Miller, (Miller, Die Mikroorganismen der Mundhöhle, Leipzig, 1888, 217; Bacillus gingitae pyogenes Sternberg, Manual of Bact,

Flagge, Die Mikroorganismen, a Auu., ., 1896, 427, Migula, Syst. d. Bakt., 2, 1900, 393) Isolated in an epidemic of scurvy in Jassy.

Bacterium gliscrogenum Malerba and Sanna-Salaris (Malerba and Sanna-Salaris, Lavori eseguiti nell'Istituto fisiol. di Napoli, 2, 1883, 13 and 95, Bactilus gliscrogenus Trevisan, I generi e le specie delle Batteriacee, 1889, 14) Front urine

Bacterium gonnermanni Migula. (Ba. cillus tuberigenus 6 Gonnermann, Landwirtsch. Jahrb , 25, 1894, 657; Migula, Syst. d Bakt., 2, 1900, 418) From root nodules of lupine.

Bacterium gracilescens Weiss (Arb bakt, Inst. Karlsruhe, 2, Heft 3, 1902, 259.) From fermenting asparagus and malt.

Bacterium gracullimum Weiss (Arb bakt, Inst. Karlsruhe, 2, Heft 3, 1902, 235.) From bean and asparagus infusions.

Bacterium granulatum Henrici (Henrici, Arlı, bakt Inst Karlsrube, I, Heft 1, 1894, 33; not Bacterium granulatum Chester, Man. Determ Bact, 1901, 189) From cheese.

Bacterium granulosum Weiss (Weiss, Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 212; not Bacterium granulosum Lehmann and Neumann, Bakt Diag, 5 Aufl, 2, 1912, 306) From vegetable infusions

Bacterium gryllalalpae Metalnikov and Meng. (Compt rend Acad Sci, l'aris, 201, 1935, 367.) Trom discased larvae of the cricket (Gryllotalpa gryllotalpa)

Bodetrum gunnosum Ritsert (Rit sert, Ber. d. pharmaz Gesell, 1, 1891. 389; abst in Cent f Bake, 11, 1892. 730; Bacillus gunnosus Migula, Syst d. Bakt, 2, 1900, 873) A myture of a spore-forming rod and a streptocorcus See Bacillus gunnosus Happ and Vicrococcus gunnosus Happ.

Bacterium halans (Zimmermann) Mi gula. (Bacillus halans Zimmermann, Die Bikterien unserer Trink-in Nutzwässer, Chemnitz, 2, 1894, 54, Migula, Syst. d Bakt, 2, 1900, 129) From water.

Bacterium helictricens Steinhaus. (Jour. Bact., 42, 1911, 762 and 773.) From the walking stick (Diapheromera femorata)

Bacterium herbicola a aureum Geilieger (Mitteil a il Gelacte di Lebensmitteluntersuchungen u llys, 12, 1921, 262) From corn mesl This is a variety of Bacillus herbicola Burri and Düggeli.

Bacterium terbienta rubrum Düggeb. (Düggeb, Cent. f. Bakt., 11 Abt., 12, 1901, 605, Bactersum herbicola β rubrum Lehmann and Neumann, Bakt. Diag , 4 Aufl , 2, 1907, 356 ) From germinating plants, roots and harley seeds

Bacterium hexacarbororum Störmer (Jahresber d Vereinigg f angew Botanik, 5, 1907, 116) From soil Utilizes benzene and certain benzene denvatives

Bacterium Indiam Goobii (Russin Health Resort Service, 5, 1923, 3) Attacks ethane and other hydrocarbons.

Bacterium hirudenicolieum Lehmensiek (Cent f Bakt, I Abt, Orig., 147, 1941, 317, see Biol Abst., 18, 1914, No. 6761) Symbiotic in the intestines of Hirudo officinalis and H. medicinalis

Bacterium hashigaki var. glueuronseum II and III Takahashi and Asai. (Cent f Bakt, II Abt, 87, 1933, 395 and 405) From dried persimmons (hoshigaki)

Bacterium infectiodum Chester (Hacillus filiformis haraniensis Sternberg, Man of Bact, 1803, 650, Bacterium filiformis haraniensis Chester, Ann Rept. Del Col Art Ply Sta. 9, 1897, 126, Chester, Man Determ Bact, 1001, 181.) From the Inver of a yellow fever cadaver Americkie

Boelerum inocum Chester (Wille, Wien kim Wochnschr, 1892, No 1-2; Bacillus lactis inocuus Kruse, in Hugge, Die Mikrourganismen, 3 Aufi, 9, 1896, 322, Bacterium lents inocuus Chester, Ann Rept Del Col Agr Exp Sta, 9, 1897, 82, Chester, Man Determ Bact, 1991, 383 - From milk.

Bacterium intrinsectum Steinhaus (Jour Bret, 42, 1911, 761 and 771) From an unidentified leaf beetle.

Batterium ingenium Buningstiner (Deutsche Monatschr f Zahnhedk., 27, 766, Batterium jogenum Brunnstrier, Ergels d gesum Zahnhedk, 7, 1911, 752 and 729, B. ogenum Kingler, Jour. Alhol Dant. Soc., 19, 1915, 152.) From the nouth. Begunded as identical with Jodicoccus raginatus Miller by Kingler (foe, cit.).

Barterium kreatumalaerae Miguls. (Bacillus septicus keratomalaerise Bales, Bakteriol. Untersuch. d. sept. Prozesse d. Kindesalters, Leipzig, 1889; Migula, Syst. d. Bakt., 2, 1900, 363.) From an infected cornea.

Bacierium Anipowitchi Issatchenko. (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 150.) From sea water. A phosphorescent bacterium found to be pathegonic for the mealworm (Tenebrio molitor) by Pfeiffer and Stammer (Titale L. Morph. u. Okol. d. Tiere, 20,

1930, 157).

Bacterium kralii (Dyar) Chester.
(Bacillus kralii Dyar, Ann. N. Y. Acad.
Sci., 8, 1895, 376; Chester, Ann. Rept.
Del. Col. Agr. Exp. Sta., 9, 1897, 93; not
Bacterium kralii Chester, Man. Determ.
Bact., 1901, 166) Received as Bacillus
bulyricus from Kral's laboratory by
Dyar. The 1900 Kral Catalogue list
scultures of Bacillus bulyricus Botkin and
Bacillus bulyricus Hueppe. As Dyar
tound that the characters of his culture
differed from those of Bacillus bulyricus
Hueppe, Dyar's culture was probably
Bacillus bulyricus Botkin.

Bacierum kralıi Chester. (Bacillus fuscus liquefaciens Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 375; Bacterium fuscus liquefaciens Chester, Ann. Rept. Del Col. Agr Exp Sta., 9, 1897, 103, Chester, Man. Determ. Bact., 1901, 166. Bec ceived as Baculus fuscus from Kral's laboratory by Dyar who also found it in air. The 1920 Kral catalogue lists Bacillus fuscus Flugge syn. Bacterium bruneum Schrotter (sic), braunrother Bacillus Maschek

Bacterium laeru Migula. (Bacillus viscosus No. 1, van Lacr, Extrait des mémoires couronnés et autres mémoires, Acad. Royale de Belgique, 1889, 36; sec Kramer, Bakteriol. In ihren Beziehungen zur Landwirtsch. 9, 1892, 119; Bacillus viscosus cerevisiae Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 359; Bacterium viscosus cerevisiae Chester, Ann. Rept. Del Col. Agr. Exp. Sta., 9, 1897, 78; Migula, Syst. d. Bakt., 2, 1900, 402; Bacterium viscosum Chester, Man.

Determ. Bact., 1901, 128.) From beer, yeast, air, bread. Causes a slimy fermentation.

Bacterium laevolacticum Migula. (Bacillus acidi laevolactici Schardinger, Monatsh. f. Chemie, 11, 1890, 544; Migula, Syst. d. Bakt., 2, 1900, 406; Bacterium acidi laevolactici Lehmann and Neumann, Bakt. Diag., 4 Aufi., 2, 1907, 178.) Fron milk

Batterium laminariae Billet. (Compt. rend. Acad. Sci., Paris, 106, 1888, 293, Billetia laminariae Trevisan, I generie le specie delle Batteriacce, 1889, 11; Kurthia laminariae De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 931.) From rotting sea weed. The type species of the genus Billetia Trevisan.

Bacterium langkatense Ifoning. (Cent. f. Bukt., II Abt., 37, 1913, 381) From tobacco plants in Sumatra.

Bacterium largum (v. Klocki) Migula. (Bacillus largus v. Klocki, Ann. Inst Past., 9, 1898, 728; Migula, Syst. d Bakt., 2, 1900, 448.) From the intestines of doss.

Bacterium lepierrei Chester. (Bacille fluorescent pathogène, Lepierre, Ann. Inst. Past., 9, 1895, 643; Chester, Man. Determ. Bact., 1901, 182.) From cistern water.

Water.

Bacterium lethalis (Babes) Chester.

(Proteus lethalis Babes, Progrès Médical

Le 2000 Chapter Ann Rent Del.

1901, 249.) From lung gangrene in man. Bacterium leucaemiae Migula. (Lucet, Jahresber. ü. Fortschr. in d. Lehre v. d. path. Mikroorg., 7, 1891, 319; Bactilus leucaemiae canis Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1890, 258. Bacterium leucaemiae canis Chester, Ann. Rept. Del. Col. Agr. Evp Sta., 9, 1897, 119, Migula, Syst., d. Bakt., 2, 1900, 442, Bactilus leucaemiae Chester, Man. Detern. Bact., 1901, 261.) From a deg with leukemiae.

Bacterium limbatum Migula. (Bacterium limbatum acidi lactici Marpmann, Ergänzungshefte d. Centralb. f. allg. Gesundheitspflege, 2, 122; Bacıllus limbatus acidi lactici Sternberg, Man. of Bact., 1833, 645; Mıgula, Syst. d. Bakt., 2, 1900, 407.) From fresh milk

Bacterium lincola (Muller) Cohn (Vibrio lincola Müller, Vermium Historia, 1773, 39; Cohn, Beitr z Biol d Pflanz., 1, Heft 2, 1872, 170, Bacillus lincola Trevisan, I generie le specie delle Batteriacce, 1889, 18) From stagnant water, infusions, etc.

Bacterium lini Migula. (Winogradsky, Compt. rend. Acad. Sci., Paris, 121, 1893, 742; Migula, Syst. d. Bakt., 2, 1900, 513) From retting hemp

Bacterium linkoi Issatchenko (Recherches sur les microbes de l'Océan Glscial Arctique (in Russian) Petrograd, 1914, 154) From sca water.

Bacterium liquefacens cammuns (Sternberg) Chester. (Bacillus liquefacens communus Sternberg, Man of Bact., 1893, 689, Chester, Ann Rept Del. Col. Agr. Exp. Sta. 9, 1897, 91, Bactilus cammunis Migula, Syst d Bakt., 2,1007, 725; not Bactilus communis Jackson, Jour. Inf. Dis., 8, 1911, 241) From the fecce of yellow fever patients

Bacterium litoreum Warming. (Warming, Danmarks Kyster levende Bakterier, 1875, 398, Bacillus litareus Trevisan, I generic le specie delle Batterinece, 1889, 18.) From sea water

Bacterium loculosum Migula. (Facherbacillus, Clauss, Inaug. Diss., Würzburg, 1889, 27; Migula, Syst d Bakt, 2, 1900, 408) From milk

Bactersum Iuceti Migula (Lucet, Ann. Inst. Past., §, 1889, 941). Bacullus cuniculacida thermophilus Kruse, m Pügge, Die Mikroorganismen, 3 aufl. §, 1896, 418, Migula, Syst. d Bakt. £, 1900, 507. Bactersum cuntenhada thermophilus Chester, Ann. Itept. Del Col Agr. Exp Sta. p., 1897, 83; Bactersum cuniculacida Chester, Man. Deverm Cantechnet, 1901, 140). Associated with an epirootic in rabbits and guinea pigs.

Bacterium ludwigi Karlinski. (Hyg Rundschau, 5, 1895, 685.) From the water of the hot springs at Ilidze in Bosnia.

Bacterium Inteolum Henrici. (Henrici, Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 51, Migula, Syst. d Bakt, 2, 1900, 455) From cheese

Bacterium Intescens Migula, (Der gelbe Bacillus, Lustig, Diag d Bakt, d Wassers, 1893, 78, Migula, Syst d Bakt, 2, 1900, 476) From water

Backerum lukeum Adametz. (List, Inaug Diss, Leipzig, 1855, 53, Adametz, Bakt Nutz. u. Trinkwässer, Mitteil. d. osterr Versuchsstation lur Bratierei und Malzerei in Wien, 1888, 48.) From the stomach contents of sheep and from water

Bactersum margarineum Migula. (Margarinbacillus α, Jolles and Winkler, Ztschr f Hyg., ε0, 1805, 102, Migula, Syst d. Bakt, ε, 1900, 419.) From margarine.

Bacterium marinum Issatchenko. (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 238) From sea water

Bactersum maydis Maiocchi (Maiocchi, Bollet d Accad medic d Roma, October, 1881, Bacillus maydis Trevisan, I generi e le specie delle Batteriacec, 1889, 17) From corn (maize) infusions

Bactersum medanense Honing (Cent f Bakt, II Abt, 37, 1913, 382) From the peanut plant (Arachis hypogaea).

Bacterum melolonthae liquefaciens Paillot (Compt rend See Biol, Paris, 68, 1916, 1102) From the weekchafer (Melolontha melolontha) According to the author's system of nomenclature, this is presumably a synonym of Bacillus melolonthae liquefaciens.

Bacterium meningitidis (Neumann and Schaffer) Chester (Bacillus meningitidis purulentae Neumann and Schreffer, Arch I pith Anat. 109, 1887, 477; Chester, Ana Rept Del Col Agr. Evp Sta. 9, 1897, 71, Bacillus neumanni Migula, Syst di Bakt. 2, 1900, 731; not Bacillus neumanni Herter, in Just, Botan Jahresber, 2 Abt., 39, 1661 4, 1915, 743, Bacillus meningitidis Chester, Man. Determ. Bact., 1901, 213.) From pus from an individual who died of purulent meningitis.

Baclerium merismopedioides Zopt. (Zopt, Die Spaltpille, 1 Aufl., 1883, 56; Bacillus synchyseus Trevisan, I genetie le specie delle Batteriacee, 1889, 18; Baclerium synchyseus DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1022.) Front canal water.

Bacterium microsporum Trevisan. (Trevisan, Rendio. d Instit. Lombardo, Ser. 2, 15, 1870; Bacillus microtis Trevisan, I generie le specie delle Batteriacce, 1889, 18; Bacterium microtis DeToni and Trevisan, ia Saccardo, Sylloge Fungarum, 8, 1889, 1025.) From water and puttefying infusions.

Bacterium minutum (Zimmermann) Migula. (Bacillus minutus Zimmermann, Die Bakterien unserer Trink-ur-Mutzwasser, Chemnitz, 2, 1894, 56; Migula, Syst. d. Bakt., 2, 1909, 423.) From water.

Bacterium monachae von Tubeuf. (v. Tubeuf, Forsilieh - naturwissensch. Itsehr. 1, 1892, 34; Bactilus monachae Migula, Syst. d. Bakt., 2, 1900, 742.) From the larvae of a moth (Lymantria monacha).

Bacterium multipediculum (Flugge) Chester. (Bacillus multipediculus Flugge, Dio Mikroorganismen, 2 Aul, 1886, 323; Chester, Aan. Rept. Del Col. Agr. Exp. Sts., 9, 1897, 101) Isolated frequently as a contamination on potato media.

Bacterium muripestifer (Kruse) Chester. (Bacillus der Mauseseuche, Laser, Cent. f. Bakt, 11, 1822, 184; Bacillus muripestifer Kruse, in Flugge, Die Mittoroganismen, 3 Aufl., 2, 1896, 432; Chester, Ann. Rept Del. Col Agr Exp Stn. 9, 1897, 87.) From the spleen of a field mouse. Associated with a plague of field mice.

Bacterium nacreaceum (Zimmermann) Migula. (Perlmutterglänzender Bacilus, Keck, Inaug Diss., Dorpat, 1890, 40; Eberbach, Inaug. Diss., Dorpat, 1800; Bacillus nacreaceus Zimmermana, Die Bakterien unserer Trink- und Nutzmäser, Chemnitz, 2, 1891, 34; Migula, Syst. d. Bakt., 2, 1900, 426.) From water.

Bacterium naphthalinicus Tausson (Planta, 4, 1927, 214) From oil-soaked soils at Baku, Russia. Oxidizes naphthalene.

Bacterium nicolaieri Migula. (Kapselbacilius, Nicolaier, Cent. f. Bakt, 16, 1894, 601; Migula, Syst. d. Bakt., 2, 1900, 354.) Associated with purulent nephritis.

Bacterium nicotianum Bucherer. (Cent. f. Bakt., II Abt., 105, 1942-43, 446.) From fermenting tobacco leaves.

Bacterium nicotinobacter Bucherer. (Cent. I. Bakt., II Abt., 105, 1942, 170) From a mixture of soil, manure and rotting materials. Gram-variable.

Bacterium nicotinophagum Bucherer. (Cent. f. Bakt., II Abt., 105, 1942, 167.) From a mixture of soil, manure, and rotting materials. Also from fermenting tobacco leaves (tbd., 446).

Bacterium nitens Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 459) From the intestines of birds.

Bacterium nomae (Schimmelbusch) Migula. (Bacillus nomae Schimmelbusch, Deutsch. med. Wochnschr., 1889, No. 26; Migula, Syst. d. Bakt., 2, 1900, 384.) Found in necrotic tissues.

Bacterium oblongum (Boutroux) De-Toni and Trevisan. (Micrococcus of longus Boutroux, Annales de l'École normale supérieure, Sér 2, 6, 1831, 67, Bacillus oblongus Trevisan, I generi e le specie delle Batteriacce, 1889, 16; DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 3, 1889, 1921; Bacterium gluconteum Miquel and Cambier, Traité de Bact, 1902, 605; not Bacterium gluconicum Hermann, Biochem. Zeit , 192, 1928, 1939) From vinegar. May be an acetobacter.

Bacterium ogatae Migula. (Ogata, Cent f. Baht., 9, 1891, 442; Migula, Syst d. Bakt., 2, 1900, 389) From dust.

Bacterium orchiticum (Kruse) Chester. (Bacillus zur Rotzdiagnose, Kutscher, Zischr. f. Hyg., 21, 1895, 156; Bacillus orchiticus Kruse, in Flurge, Die Mikroorganismen, 3 Aufl., 2, 1896, 455, Chester, Ann. Rept. Del. Col. Agr. Exp Sta., 9, 1897, 99) From nasal secretions of a glandered horse.

Bacterium osteophilum Billet (Contribution à l'étude de la morphologie et du développement des Bactériacées, Bull. Sei de la Trance et de la Belgique, Paris, 21, 1890, 149) From macerated human bones.

Bacterium ovale Migula (Bacillus No. 17, Pansini, Arch I. pathol Anat u Physiol , 122, 1890, 451, Migula, Syat d. Bakt., 2, 1900, 453; not Bacterium otale Chester, Man Determ Bact , 1901, 171 (Bacillus ovalts Wright, Mem Nat Acad. Sci., 7, 1895, 435). From fecces

Bacterium oratium Migula (Bacellus oratius minutssimus Unian-Tommand), Monatsh f. prakt. Dermatol, 9, 1859, 59; Migula, Syst d Bakt, 2, 1900, 417. Bacterium oratus minutissimus Chester, Ann. Rept. Del Col Agr. Exp. Sta., 9, 1897, 139, not Bacterium contum Chester, Man. Determ. Bact., 1901, 177 (Bacillus ruber oratus Europing, Arch. néel Sci. exact. et nat., 56r. II, 1808, 297)) From human skin with seborrheic ecrema

Backerium pallens Henrici (Arb bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 36) From cheese

Bacterium pallescens Henrici (Arb bakt, Inst. Warlsruhe, I, Heft I, 1894, 35) From cheese

Bacterium pallidum Henrici (Arb bakt. Inst Karlsruhe, I, Heft 1, 1891, 31, Ulrina pallida Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 76) From cheese

Bacterium pallidor Chester. (Bactilus fueus pallidor Dyar, Ann N Y Acad, Sci., 8, 1805, 361; Bacterium fuscus pallidor Chester, Ann Rept. Del Col Agr. Exp. Sta., 9, 1807, 111; Chester, Man Determ Bact., 1901, 171) Culture received by Dyar from Krål's laboratory labeled Bacillus latericeus. Dyar renames this because the culture does not agree with Bacillus latericeus does not agree with Bacillus latericeus. Eisenberg However, the 1900 Kral catalogue indicates that this was Bacillus laterieus Adametz and Wichman syn ziegelrother Bacillus, Adametz, Bacterium latericeum Lehmann and Neumann

Bacterium papillare Issatchenko. (Recherches sur les microbes de l'Océan Clacial Arctique (in Russian). Petrograd, 1914, 149) From sea water.

Bacterum paradozu (Kruse) Chester, (Typlus ahnlicher Bacillus, Kruse and Pasquale, Zischr f Hyg, 16, 1894, 19; Bacillus paradozus Kruse, in Flugge, Die Mikroorganismen, 3 Auf 2, 1866, 373; Chester, Ann Rept Del Col Agr. Exp. Sta, 9, 1897, 71) From the liver in a case of dysentery.

Bacterium paraviscosum Buchanan and Hammer (Iona Sta Coll Agr. Exp Sta. Res Bull 22, 1015, 266) Stated to be similar to Bacterium viscosum of various authors

Bacterium patelliforme Honing. (Cent f Bakt, II Abt, 37, 1913, 378) From tobacco plants in Sumatra

Bacterium paterforme Migula. (Bacillus ablicans pateriformis Unna-Tomnusedi, Monatsh prakt Dermatol, 9, 1889, 58; Migula, Syst d Bakt, 2, 1900, 415) Found on human skin with seborrheic erzema.

Bacterium petersii Migula. (Bacterium C, Peters, Botan. Zeitung, 47, 1889, Bacilla accietus petersii Kruses, in Flugge, Die Mikroorganismen, 3 Auf, 2, 1893, 385, Bacterium acetieus petersii Chester, Ann. Rept. Del Col. Agr Evp Sta. 9, 1807, 77, Migula, Syst. d Bakt, 2, 1900, 307, Bacterium aceticum Chester, Man Determ Bret., 1901, 127, not Bacterium aceticum Bagnaky, Zischt. f. phys Chem, 12, 1889, 437) From fermenting dough

Battrium photometricum Engelmann. (Engelmann, Jour Roy. Microscop Soc., 1882, 656 and 1883, 236; Bacillus photometricus Trevisan, I generi e le specie delle Butteriacee, 1889, 18.) Saprophytic.

Bacterium piluliformans (Müller-Thur-

gra) Migula. (Bacillus piluliformans Miller-Thurgau, Jahresber, d. Versuelustation zu Wädenamil 1892/3, 3, 1894, 92; Migula, Syst. d. Bakt., 2, 1900, 513.)

Trota a disease of red wine.

Batterium pituitorum Migula. (Bacillus lectie pituitei Ineliere, Berlines kim. Woch.zedr., 1857, 631; Bacterium lactis pituitori Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1907, 86; Migula, Syat. d. Bakt., 2, 1909, 493; Bacterium lactis Chester, Man. Determ. Bact., 1901, 143; not Bacterium lactis Baginsky, Ztrehr. I. phys. Chem., 12, 1858, 437.) From milk.

Bacterium pilyocampae Dufrenoy, (Compt. rend. Soc. Biol., Paris, 71, 1919, 283.) From direased caterpillars of the processionary moth (Cnethocampa pilyo-

campa)

Bacterium pleuropneumoniae Migula. (Diplococcus der Brustseuche der Plerde, Schlutz, Arch. f., pathol. Anat. u. Physioh., 107, 374; Migula, Syst. d. Bakt., 2, 1000, 315) Frequently isolated from horses with pneumonia.

Hacterum plicatum (Zimmermann) Chester (Hacillus plicatus Zimmermann, Die Hakterien unseere Trinks und Nutzwisser, Chennitz, 1, 1823, 51; Chester, Ann. Rept. Del. Col. Agr. Exp. Sta. 9, 1837, 103; Bacterum plicatirum Migula, Syst. d. Bakt., 2, 1900, v and 453). From water.

Bacterium pneumopecurium Chester. (Bacillus of sporadie pneumonia of cattle, Smith, U. S. Dept Agr. Bur. Animal Husbandry, 1895, 136; Chester, Man. Determ. Baet, 1001, 137.) Similar

to Pasteurella suilla.

Baclerium pneumosepticum (Babces) Migula. (Bacillus pneumosepticus Babce, Progrès méd. roumain, ¢, 1889; not Bacillus pneumosepticus Kruse, in Flügge, Dio Mikroorganismen, 3 Auli., 2, 1890, 408; Migula, Syst. d. Bakt., ¢, 1900, 377.) From a case of septic pneumonia.

acterium polymorphum (Frankland Frankland) Migula. (Bacillus polyus Frankland and Frankland, Philos. Trans. Royal Soc. Louise 17, 1887, B, 275; Migula, Syst. d. Edit., 1990, 420.) From air.

Bacterium porri Majocchi, Olije, chi, in Tommasi Crudeli, Antimi patologica, I, 1882; Bacillus rerundrit, garis Kulmemann, Monatsh, I, pah, Dermatol., 9, 1889; Bacillus porri Traisan, I generi e le specie delle Batteriam, 1859, 13.) From warts.

Bacterium prodeniae Metalnikov and Metalnikov. (Compt. rend. Acad Agric., France, 18, 1932, 206.) From a blackened dead Jarva of a moth (Pro-

denic litura).

Badtrium projusum (Frankland att Frankland) Migula. (Bacillus projusa Frankland and Frankland, Philos. Trans Royal Soc. London, 178, 1887, B, 278, Migula, Syst. d. Bakt., 2, 1990, 4213 From air.

Bacterium pseudoaquatile Miguls. (Bacillus aquatilis α, Tataroff, Inaug. Diss., Dorpat, 1891, 44; Migula, Syst. d Bakt., 2, 1900, 470.) From water.

Bacterium pseudoconjunctivilitu (Kruse) Chester. (Kartulis, Cent. f. Bakt., f. 1887, 289; Bacillus pseudoconjunctivilidis Kruse, in Flogge, Du Mikroorganismen, 3 Aufl., g. 1896, 441; Chester, Ann. Rept. Del Col. Agr. Exp. Sta., 9, 1897, 1985.) From conjunctival legerations.

Bacterium pseudofilicinum Migula. (Fadenbacillus, gunschek, Bakteriologische Untersuchungen der Leitmentter Trinkwässer, Leitmeritz, ISS7; Migula, Syst. d. Bakt., 2, 1900, 451.) From water.

Bacterium pseudoinfluenzaa (Kruse) Cheaste. (Pseudoinfluenzabaciilus, Pfeiifler, Ztschr. f. 11yc., 15, 1893, 357; Bacillus pseudoinfluenzaa Kruse, in Tlugge, Die Mikroorganismen, 3 Aufi, 2, 1896, 439 (Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 66.) From

water.

\*\*Racterium pseudokeratomalaciae MiBacterium pseudokeratomalaciae Migula. (Loeb, Cent. f. Bakt., 10, 1891,
gula. (Loeb, Cent. f. Bakt., 2, 1900, 359.)
369; Migula, Syst. d. Bakt., 2, 1900, 359.)

A capsulated bacterium from infected cornea of a child.

Bacterium pseudomultipedieulum Migula. (Bacillus multipedieulus flavus Zimmermann, Bakt. unser Trnk- u Nutzwässer, Chemnitz, 2, 1894, 42, Migula, Syst. d. Bakt., 2, 1900, 332) From senage.

Bacterium pseudopneumonieum (Passet) Chester, (Bacillus pseudopneumonicus Tasset, Untersuchungen über die Actiologie der eiterigen Phegmone des Menschen, 1885, 40; Chester, Ann Rept Del. Col Agr. Exp Sta. 9, 1897, 140, Brueclla pseudopneumonieum Pribram, Klassifikation der Schizonyeeten, Leipig und Wien, 1933, 68) From pus

Bacterium punctum (Mueller) Ehrenberg. (Manas punctum Mueller, Infusoria, 1786, 3, Bacilus punctum Trevisan, I generie ele specie delle Batteriacec. 1859, 18.) From swamps and stagnant water.

Bacterium putidum Chester (Bacillus gracilis cadateris Sternberg, Man of Bact., 1893, 733, Chester, Man. Determ Bact., 1901, 140) From a liver

Bacterum pyaemicum Migula (Levy, Cent. f. klin. Med., 1890, No 4, abst in Cent. f. Bakt, 8, 1890, 88, Migula, Syst data, 2, 1900, 443) From a case of Dvemia.

Bacterium pyocinnabareum (Kruse) Clester, (Ferchmin, Ueber rote Ederung, Wratsch, 1892, No. 24 and 25, abst. in Cent f. Bakt, 15, 1803, 103, Bacillus pyocinnabareus Kruse, in Fluges, Die Mikroorganisem, 3 vul. 4, 2, 1806, 304; Chester, Ann Rept. Del Cal Agr. Exp Sta., 9, 1897, 113) From a case of red pus

Bacterium pyogenes Chester. (Fuchs, Inaug Diss., Greifswald, 1890, Bacillus pyogenes anacrobius Kruse, in Flügge, Die Mikroorganismen, 3 Aufl. g., 1896, 244; not Bactlus pyogenes anacrobius Bla-Johan, Cent.f. Bakt., IAbt., Ong., 87, 1922, 209; Bacterium pyogenes anacrobius Chester, Ann. Rept. Del. Col Agr., Fay. Sta., g., 1897, 127, Chester, Man. Determ. Bact., 1901, 184; not

Bacterium pyogenes Migula, Syst. d. Bakt, 2, 1900, 381, not Bacterium pyogenes Ward, Jour. Bact, 2, 1917, 619.) From stinking pus from a rabbit.

Bactersum pyraustas Nos. 1-7 Metalnikov and Chorine (Internat Corn Borer Invest, Sci Repts., 1, 1928, 62.) From diseased corn borer larvae (Pyrausta nubilalis 11b).

Bacterum radiatum Chester. (Del. College Agr Lypt Sta Ann. Rept., 11, 1900, 56) From soil

Bacterium ramificans Weiss (Arb. bakt Inst. Karlsruhe, 2, Heft 3, 1902, 229) From bean infusions

Bacterum rangierinum Honine, (Honing, Cent. f. Bakt., II Abt., 87, 1913, 379, Placamobacterium rangiferinum Pribram, Klassifikation der Schizomyeeten, Leipzig und Wien, 1933, 78.) From fermenting tobacco

Bacterium repens Miche. An organism associated with Bacterium folicola

de Jongh
Bacterum retiformans Glokhorn.
(Cent f Baht, 11 Abt, 50, 1920, 421.)
A sulfur bacterum from garden soil.
See Manual, 5th ed., 1939, 80 for a description of this organism

Bacterium rhizopodicum Migula. (Bacillus rhizopodicus margarineus Jolles and Winkler, Zischr f Hyg., 20, 1895, 105, Migula, Syst d Bakt, 2, 1900, 452.) From margarine

Roderium rosem Lossli (Lossli, Inaug. Diss., Dorptt, 1833, quoted from Migula, Syst d. Birkt, 2, 1900, 484; Bacillus roseus Nepveux, Thèse, Pac. Pharm. Paris, 1920, 115 From sand. Bacterium rubipenosum Kern. (Kero, Arb. bakt. Inst. Karlsrube, 1, 1eft, 4, 1850, 456; Bacillus rubipenosus Nepveux, Thèse, Fac. Pharm., Paris, 1920, 113; not Bacillus rubipenosus Catlano, in Cobn. Beitr z Biol d Pflancen, 7, 1806, 583). From the intextince of birds.

Bacterium rubrum Schneider. (Balterium rubrum Schneider, Arb. bakt. Inst Karlsrühe, 1, Heft 2, 1894, 213, also see Migula, Syst d Bakt., 2, 1993, 483. Basillus rubrum Nepveux, Thèse, Fac. Pharm., Paris, 1920, 115.) From swamp water. Difficult to distinguish from Bacterium erythromyza.

Bacterium rubrum Metalnikov and Metalnikov. (Compt. rend. Acad. Agric., France, 18, 1932, 201; not Bacterium rubrum Schneider, Arb. bact. Inst. Karlsruhe, 1, Heft 2, 1894, 213.) From the cotton worm (Gelechia gossyptial).

Bacterium ealinea Nigula. (Bacillus salivae minutissimus Kruse, in Flügge, Die Mikroorganismen, 3 Aufn., 2, 1896, 440; Bacterium salivae minutissimus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 6, 1897, 86; Nigula, Syst. d. Bakt., 2, 1900, 418.) From secretions of the mouth.

Mount.

Bacterium salmonicida Lehmann and Neumann. (Bacillus der Forellenseuche, Emmerich and Weibel, Arch. I. Hyg., 21, 1594, 1; Lehmann and Neumann, Bakt. Ding., 1 Aufl., 2, 1896, 249, Bacillus salmonicida Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 282; Bacterium salmonica Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 99; see Mackie et al., Final Rept. of the Furunculosis Committee, II. M. Stationery Office, Edinburgh, 1935, and Duff, Jour. Bact., 34, 1937, 49.) Pathogenie for trout.

Bacterium sanguinis Migula. (Bacillus sanguinis typhi Sternberg, Man of Bact, 1803, 732; Bacterium sanguinis typhi Chester, Ann. Rept. Del. Col. Agr. Exp Sta., 9, 1807, 89; Migula, Syst d. Bakt., 2, 1900, 506) From the blood of typhus fever patients.

Bacterium schüffneri Honing (Cent f. Bakt., 11 Abt, 37, 1913, 370) From tobacco plants in Sumatra.

Bacterium septentrionale Issatchenka. (Recherches sur les microbes de l Océan Glacial Arctique (in Russian) Petrograd, 1914, 239.) From sea water

Bacterium (Proteus) septicus (Babes) Chester. (Proteus septicus Babes, Septische Processe des Kindesalters, 1889; Bacillus proteus septicus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 279; Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 102; Bacillus septicus Chester, Man. Determ. Bact., 1901, 245; not Bacillus septicus Macé, Traité pratique de Bact., 1st ed., 1889, 455; not Bacillus septicus Migula, Syst. d. Bakt., 2, 1900, 645; not Bacillus septicus Crookshank, Textb. of Bact., 4th ed., 1900, 632) Prom the intestine of a child having septicmis.

Bacterium selosum Henrici. (Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 46.) From cheese.

Becterium siecum Issatchenko. (Recherehes sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 235.) From sea water.

Bacterium sieberti Migula. (Siebert, Inaug. Diss., Wurzburg, 1894, 13; Migula, Syst. d. Bakt., 2, 1900, 456.) From hair follicles.

Bacterium soriferum Migula. (Severin, Cent. f. Bakt., II Abt., 1, 1895, 799; Migula, Syst. d. Bakt., £, 1900, 433.)
From manurc.

Bacterium spiniferum (Unna-Tommasoli) Chester. (Bacillus spiniferus Unna-Tammasoli, Monatsh. f. prakt. Dermatal., 9, 1889, 58; Chester, Ann. Rept Del Col. Agr. Exp. Sta., 9, 1897, 110 and 143) From human skin with soliorrheic eczema.

Bacterium spinosum Weiss. (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 219) From fermenting beets.

Bacterium spirale Issatchenko. (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 233.) From sea water.

Bacterium sputigenum Chester. (Bacillus aerogenes sputigenus capsulatus Herla, Archiv de Biol., 14, 1895, 403; Chester, Man. Determ Baet., 1901, 133; not Bacterium sputigenum Migula, Syst. d. Bakt., 2, 1900, 378.) From the blood of a mouse which had been inoculated

From the mouth.

Racterium sounmatum Weiss, (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 242.) From vegetable infusions.

Racterium sanamosum Kern (Arb. bakt. Inst. Karlsruhe, f. Heft 4, 1897. 436 ) From the stomachs and intestines of birds.

Bacterium stalactitigenes Honing (Cent. f. Bakt., II Abt., 57, 1913, 375.) From tobacco plants in Sumatra

Bacterium sternbergii Migula, (Bacillus angerobius liquefaciens Sternberg. Man of Bact , 1893, 693, Migula, Syst d. Bakt., 2, 1900, 411; Bactersum angerobicum Chester, Man, Determ Bact . 1901, 193; Bacillus sternbergis Winslow. Kligler and Rothberg, Jour Baet . 4, 1919, 487.) From intestines of yellow fever cadavers.

Bacterium steraidiclasium Araqudi and Ercoli, (Boll Sez. ital Soc. intern. Microbiol , 20 (3), 1941, 000, also see Arnaudl, Cent. f. Bakt, Il Abt, 105, 1942-43, 352) Source not given in second paper. From bakers' yeast

Bacterium streckers (Trevisan) Migula (Baeillus citreus cadareris Strassmann and Streeker, Ztsehr. f. Medizinalbenmte, ISSS, No. 3, Bacillus streekers Trevisan, I generi e le specie delle Batteriacce, 1889, 17; Bactersum estreus eadareris Chester, Ann. Rept Del Col. Agr. Exp. Sta., 9, 1897, 108, Migula, Syst d. Bakt., 2, 1900, 460; Baetersum citreum Chester, Man. Determ. Baet , 1901, I67 ) From a cadaver.

Bacterium subeitricum Weiss. (Arb. bakt. Inst. Karlsruhe, 2, Helt 3, 1902, 257) From vegetable infusions

Bacterium subfuscum Kern. (Arb bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 461 ) I'rom the intestines of birds

Bacterium subluteum Migula. (Bacillus luteus von Dobrzyniccki, Cent f. Bakt., I Abt., 21, 1897, 835; Migula, Syst d Bakt., 2, 1900, 456 ) From the mouth.

Bacterium sulfureum Holschewnikoff. (Helschewnikoff, Fortschr d. Med., 7, 1889, 201 and Ann. de Microgr., 1, 1888-1889, 261; Bacillus sulfureus Trevisan, I

generi e le specie delle Batteriacee, ISS9.

17.) From sewage.

Bacterium sumatranum Honing. (Cent. f. Bakt., II Abt., 57, 1913, 374.) From tobacco plants in Sumatra.

Bacterium surgeri (Dornic and Daire) Buchanan and Hammer. (Bacillus surgeri Dornic and Daire, Bull, mens, de l'Office de renseignements agricoles. 6. 1907, 146, Buchanan and Hammer, Iona Sta Coll Agr. Exp. Sta. Res. Bull, 22, 1915, 254 ) From serum produced in the manufacture of casein. Causes show milk. Closely related to the Bacterium bulgaricum group, according to Buchanan and Hammer.

Bactersum sycosiferum Migula. (Bacillus sycosiferus fociides Unna-Tommasoli, Monatsh f. prakt Dermatol., 8, 1889, 183: Migula, Syst. d. Bakt. 2. 1900, 385) From the beard of a patient with bacillogenic sycosis.

Bacterium syphilidis (Kruse) Migula, (Syphilisbacillus, Lustgarten, Wiener med. Woelinsehr , 1884 and Wiener med Jahrbücher, 1885, Pacinia syphilitica Trevisan, I generi e le specie delle Batteriacee, ISS9, 23, Bacillus syphilidis Kruse, in Plagge, Die Mikroorganismen. 3 Aufl . 2, 1896, 514; Migula, Syst. d. Bakt . 2, 1900, 496 ) From syphilis.

tachylonum Tischer. Bacterium (Tischer, Deutsche med Wochnsehr., 1894. No. 25-28: Bacillus tachutonus Migula, Syst d Bakt , 2, 1900, 655) From leces in a case of cholera.

Bacterium tenue Migula, (Bacillus tenuts sputigenes Pansini, Arch f. nath. Anat . 123, 1890, 453, Bacillus sputigenus tenus (sie) Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 431; Bacterium aputigenes tenuis Chester, Ann. Rept Del. Col Agr Exp Sta , 9, 1897, Migula, Syst d Bakt , 2, 1900, 457.) Associated with advanced phthisis and catarrhal pneumonia.

Bacterium termo (Mueller) Ehrenberg. (Monas termo Mueller, Infusoria, 1786; Ehrenberg, Abhandl. Akad. Berl., 1830, Palmella infusionum Ihrenberg, Infusinnsthierchen, 1838, 526; Zoogloea termo Cohn, Nova Acta Leop. Carnl., 24, 1853, 123; Bacillus termo Trevisan, I generi e le specie delle Batteriacce, 1889; 18.) From infusions.

Bacterum termo var. subterraneum Hansgirg. (Hansgirg, Oest. Bot., Etschr., 18S8, 6; quoted from DeToni and Trevisan, in Saccarda, Sylloge Fungorum, 8, 1889, 1025.) From damp walls in a cellar.

Bacterium thioaenes Lehmann. (Thionsaurebakterien, Trautwein, Cent. f. Bakt., II Abt., 63, 1921, 513; sbid., 61, 1924, I; Lehmann, in Lehmann and Neumann, Bakt. Diag , 7th Aufl., 2, 1927, 516; Thiobacillus trautweinii Bergey et al., Manual, 2nd ed , 1925, 39.) From canal water, sewage and soil. Regarded by Trautwein (loc. cit., 1924, 5) as closely related to Bacterium denstrificans Lehmann and Neumann. See Flavobacterium denstrificans Borgey et al. Heteratrophic and therefore wrongly placed in Thiobacillus (Starkey, Jour. Bact., 28, 1934, 387; Jour. Gen. Physiol., 18, 1935, 325).

Bacterium tholoeideum Gessner, (Gessner, Arch. f. Hyg., 9, 1889, 129; Bacillus tholoeideus DeToni and Trovisan, in Saceardo, Sylloge Fungorum, 8, 1889, 082.) From the human duodenum.

Bacterium tortuosum Zukal. (Zukal, Verh. d. zoolog botan. Geselisch., Wien, 55, 1885; Bacillus tortuosus Trevsan, I generi e le specie delle Batteriacee, 1889, 18, not Bacillus tortuosus Debono, Cent f. Bakt., 1 Abt, Orig, 62, 1912, 233) From muddy water

Batterium trenulans Ehrenberg (Ehrenberg, Abhandlungen d Berliner Akad., 1830, 38, Vibrio trenulans Ehrenberg, Die Infusionsthierehen, 1838, 79; Trevisan, Rend. Ist Lomb, 1879, 145, Bazillus trenulans Trevisan, I generi e le specie delle Batteriacce, 1889, 187 From stagnant water, infusions, etc

Bacterium trichorrhexidis Migula. (Bacillus multiformis trichorrhexidis Hodara, Monatsh. f. prakt. Dermatol., 19, 1894, 173; Migula, Syst. d. Bakt., 2, 1900, 437.) From healthy hair showing trichorrhexis.

Bacterium truncatum Chester. (Bacillus No. XII, Adametr, Landwirtsch. Jahrb., 18, 1859; Chester, Man. Determ. Bact., 1901, 157; not Bacterium truncatum Migula, Syst. d. Bakt., 2, 1900, 407; not Bacterium truncatum Chester, Joc. ct., 195.) From Emmenthal chesse.

Bacterium tuberosum Kern. (Arb. bakt. Inst. Karlsruhe, I, Heft 4, 1896, 455, Bacillus tuberosus Nepveuv, Thèse, Fac Pharm. Paris, 1920, 113) From the intestines of birds.

Bacterium turcosum. (Quoted from Franke and Rudloff, Biochem, Ztschr., 310, 1912, 207.) Source not given.

Bacterium uniforme Weiss. (Arh. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 259) From fermenting malt.

Bacterium ureae Leube and Graser. (Leube and Graser, Arch. 7. pathol. Anat. u. Physiol., 100, 1885, 558; Bacillus ureae Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 357; not Bacillus ureae Miquel, Bull. Soc. Chin. d. Paris, 31, 1870, 391,

12, 635; Cent. ocamo. bacterium ureae Pribrani, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 78 } From urine. Leube makes no statement regarding spore formstion While Miquel's and Leube's organisms are sometimes regarded as having been identical, Miquel did not regard his Bacillus ureae as being identical with Leube's Bacterium ureae and gave them separate names Urobacillus duclauxu and Urobacillus leubei (Miquel and Cambier, loc. cit., 631 and 635). The latter name had however been previously used by Beigerinck (loc. cit.) for a different organism. Dyar credits the name Bacillus ureas to Jaksch (Ztschr. physiol Chem , δ, 1881, 395) who, honever, spoke only of a Harnstoffpilz and evidently had no pure cultures Dyar's culture which came from Krdl is listed in the 1900 Kral catalogue as

margarine.

Bacillus ureae Leube. Also see Gibson (Jour. Bact., 24, 1935, 493). Lölnis (Handb. I. landwirtsch. Bakt., 1910, 459) thinks that this species belongs in the Proteus group.

Bacterium vaillardi Migula. (Kelsch and Vailland, Ann. Inst. Past., 4, 1890, 276, Migula, Syst. d. Bakt., 2, 1900, 137.) Tomad in swellings of the lymph system in leukenia.

Beaterium intriume Migult. (Combert, Richerches expfer, microles conpunctiver, Paris, 1889; Beatilus raricaus conjunctivas Sternberg, Min. of Bret, 1893, 474; Beaterium raricous conjunctivas Chester, Ann Bept, Del Col Ar-Exp Sin. 9, 1897, 100; Miguls, Syst d Bakt, 2, 1900, 411). From the normal

conjunctiva of man

Bacterium rapiosum Weiss (Arb
linkt Inst. Karlsruhe, 2, Heft 3, 1992,
218.) From vegetable infusions

Bacterium velatum Migula. (Bacultus ubbergenus 6, Gonnermann, Landwirtsch, Jahrl., 23, 1891, 657, Migula, Syst. d. Bakt., 2, 1900, 451, Bacultus velatus Nepveux, Thèse, Pac. Plaarn, Paris, 1920, 113) From Iujune rost nodules

Bacterium vernicosum Zopf (Zopl, Beitr, z. Physiol u. Marphol, inederec Organismen, Heft 1, 1802, 63, Bacillus vernicosus Migula, Syst. d. Bakt., 2, 1900, 781.) From cotton-seed meal

Bacterium resiculosum Henrici (Arba, d. bakt. Inst. il. techn. Bochschule zu Karlsruhe, I. Heft, I., 1891, 37.) From cheese

Bacterium rillosum (Keck) Migula (Bacillus rillosus Keck, Inaug Drvs, Dorpit, 1890, 47; Migula, Syat d. Bakt, 2, 1900, 429, Plocamobacterium rillosum Pribrain, Klassifikation der Schizomyeeten, Leipzig und Wieu, 1973, 79) From water

Bacterum rinteda Migula (Bacillus riscosus 1111 Kramer, Bakteriol, in ihren Beziehungen z. Landwirtsch., 2, 1892, 144, Migula, Syst. d Bakt., 2, 1900, 510) From wine.

Bacterium viniperda Migula (Bacil-

Ius saprogenes vini IV, Kramer, Bakteriol, in ihren Beziehungen z. Landwirtsch., 2, 1892, 135; Migula, Syst. d. Bakt., 2, 1900, 446). From diseased wine. Bacterium rinde van Tieghem. (Bull. Soc. bot. France, 27, 1880, 174.). Yound

on a fungus.

Bacterium riscidum Migula. (Bacillus interesses margarineus Julles and Winkler, Zische, f. Hyg., 20, 1895, 104; Migula, Syst. d. Bakt., 2, 1900, 459). From

Bacterium viscosum Migulo (Bacillus viscosus sacchari Kramer, Sitzungsl. dl. kais, Akad. d. Wiss., Wien, 1889; Bakterol. in thren Besichungen z. Landwirtsch. z., 1892, 166; Migulo, Syst. d. Bakt., z., 1900, 417.) Smillar to Leuconostoc metauleroules except that it housefes gelatin

Bacterium viscosum non liquefaciens Statter and Warrow (Cent. f. Bakt., II Abt., 71, 1927, 117.) From puppe of moth (Eusoa segetum). Resembles Bacillus viscosus Frankland.

Bacterum ritulinum Cliester. (Bacillus der Septikämie bei einem Seekalbe, Bosso, Cent. f. Bakt., 25, 1899, 52; Cliester, Man. Determ. Bact., 1901, 113.) From a septiremia of the sea-calf (Phoca

Bacterium rituforum Migula. (Bacil-Insder acissen Ruhr der Kälber, Jensen Monatsh. I. prakt. Tierheilk., 5, 1892, 92; Maanedskrift for Dyrleger, 4, 1892-93, 140, Bactillus dysantiea vituforum Kruse, in I lägge, Die Mikroorganismen, 3 Aufl. 2, 1890, 432; Bacterium dysantiea eriuforum Chester, Ann. Rept. Del. Col. Agr. Exp. Sta. 9, 1897, 56, Migula, 53st d. Bakt. 2, 1900, 391; Bacterium dysantieach Cleaster, Man Detenn, Bact., 1901, 145 J. Associated with dysentery of ealyes

Bacterium winkleri Migula. (Margarinhacillus β, Jolles and Winkler, Ztschr f Hyg, 20, 1895, 102, Migula, Syst d Bakt, 2, 1900, 485) From margarine

Bacterium wrightiz Chester (Capsule Bacillus of Mullory and Wright, Z'schr. f. Hyg., 20, 1895, 220; Chester, Man. Determ. Bact., 1901, 133.) Frem a case of bronchopneumonia.

Bacterium zinnioides Honing. (Cent. f. Bakt., II Abt., \$7, 1913, 371.) From tobacco, peanut and other plants in Sumatra.

Bacterium zuernianum (List) Chester. (Bacillus zuernianus List, Inaug. Diss, Leipzig, 1885, 36; Chester, Ann. Rept Del. Col. Agr. Exp. Sta., 9, 1897, 83) From fresh manure and intestines of sheep, also found in water

Coccobacillus acridiorum Picard and Blanc. (Coccobacille des sauterelles. d'Herelle, Compt. rend. Acad. Sci. Paris, 152, 1911, 1413; Picard and Blane, shid , 166, 1913, 1335; Bacillus acridiorum Chatton, 161d., 156, 1913, 1708.) Front a locust (Schistocerca americana Drury)

Coccobacillus cajae Picard and Blane. (Compt. rend. Acad Sci., Paris, 156, 1913, 1334; Bacillus cajus Marchol, Revue de Phytopath Appl , I, 1914, 11.) From diseased enterpillars of Arctia caja.

Coccobacillus aibsoni Chorine. (Internat Corn Borer Invest., Sci. Repts, 2. 1929, 42: B gibsoni Paillot, B presumably indicates Bacterium, see index, p. 522, L'infection chez les insectes, 1933, 134; Bacillus gibson: Steinhaus, Bacteria Associated Extracellularly with Insects, Minneapolis, 1942, 58.) From diseased corn borer larvae (Pyraustra nubilalis).

Coccobacillus insectorum Hollande and Vernier, (Compt rend Acad. Sci., Paris, 171, 1920, 207.) From diseased caterpillars of a moth (Molacosoma castrensis).

Coccobacillus insectorum var malacosomae Hollande and Vernier (Compt. rend. Acad. Sci , Paris, 171, 1920, 208.) From diseased caterpillars of a moth (Malacosoma castrensis). Denitrobacterium thermophilum Am-

broz. (Cent. f. Bakt , II Abt., 37, 1913, 3.) A thermophilic bacterium from soil. Diplobacillus melolonthae (Compt rend. Soc Biol., Paris, 69, 1917,

5 : Annales des Épiphyties, 8, 1922, 117.)

From larvae of cockchafers (Melolontha mclolontha).

Diplobacillus pieris Paillot. (Annales des Épiphyties, 8, 1922, 129.) From diseased caterpillars of the cabbage butterfly (Pieris brassicae).

Helicobacterium aerogenes Miller. (Deutsche Med. Wchnschr., 12, 1886, 119; Bacillus helicoides De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 952 ) From the stomach. This is the type species of the genus Helicobactersum.

Helicobacterium klebsii Miller, (Die Mikroorganismen der Mundhöhle, 2 Aufl , Leipzig, 1892, 370; quoted from Buchanan, Gen. Syst. Bact., Baltimore, 1925, 327) From the mouth.

Microbacillus cutreus baregensis Robine and Hauduroy. (Compt. rend Soc. Biol., Paris, 93, 1928, 26.) From hot sulfur springs at Barèges. Fourment (Compt rend. See Biol., Paris, 98, 1928, 588) states that this species is Bacillus luteus Flugge, but Robine and Hauduroy (Compt. rend Soc. Biol., Paris, 99, 1928, 317) deny this.

Micrococcobacillus necroticans Pascheff. (See Pascheff, Bericht. d. ophthalmol Gesellsch., Heidelberg, 1916, 418 or Klin Monatsbl. f. Augenheilk, 57, 1916, 517 and 58, 1917, 97; Coccobactllus polymorphus necroticans, quoted from Bayer and v Herrenschwand, Arch. l Ophthalmol, 98, 1919, 358, Micrococcobacillus polymorphus necroticans Pascheff, Arch. d'Ophthalmol., 38, 1921, 28; Pascheff, ibid, 97.) From the human eye. Reported as the causal organism of conjunctivitis

Nitrosobacillus thermophilus Campbell (Sci , 75, 1932, 23.) From soil. Oxidizes ammonia to nitrite.

Pacinia ferrarii Trevisan. (Bacillo dell' ulcera molle, Ferrari, 1885; Trevisan, I generi e le specie delle Batteriacce, 1889, 23.)

Pacinia fickii Trevisan (Bacillus e des Conjunctivalsackes, Fick, 1887; Trevisan, I generi e le specie delle Batteriacee, 1889, 23.)

Pacinia micheli Trevisan (Michel, Luftstäbehen des Conjunctivalsecretes, 1882; Trevisan, I generi e le specie delle Batteriacce, 1889, 23) From the conjunctiva

Plocamobacterium acud lacteri Pribram (Lange Milchsuurestlübehen, Wolff, Cent f Bakt, II Abt., 20, 1908, 515, Pribram, Klassifikation der Seliizonyecten, Leipzig und Wien, 1933, 76) From milk.

Ploeamobacterium epidermidis (Bizzozero) Pribram (Leplathrix epidermidis Bizzozero, Arch. f. path. Anat., 93, 1896, 485, Pribram, loc. cit., 77) From the skin

Plocamobacterium proteolyticum (Wollman) Pribram (Glycobacter proteolyticus Wollman, Ann Inst Past , 26, 1912, 617, Pribrain, loc cit, 118)

Plocamobacterium rubrum Pribram, loc est, 78 lled cheese bacterium (Kiel)

Plocamobacterium tilsitense Prihram, loc cit, 78. From Tilsit cheese (Kiel)

Proteus hommis Borloni-Uffreduzzi (Bieterlum, Bordoni-Uffreduzzi and Di Mattei, Arel per le science meichele, 10, 1886, No. 7; abst. in Cent. f. Bakt., 1, 1887, 348, Bordoni-Uffreduzzi; Atschr f. 1897, 348, Bordoni-Uffreduzzi; Atschr f. 1897, 348, Bordoni-Uffreduzzi; bid., Proteus capsulatus septicus Banti, 10. Sperimentale, 83; Klebisella bordoni Trevisan, 1 generi ele specie delle Battenace, 1889, 25, Bacillus capsulatus septicus Krisc, in Tlugge, Die Mikroorganismen, 3 Aufl., 2, 1800, 315, Bacierum hommis capsulatus Chester, Ann. Rept. Del Col Agr Ley Sta., 9, 1897, 136; Bacterum aeguelatus and Bacterium capsulatus septicus Chester, tidul, 139; Bacterium proleus Migula, Syst. d. Bakt., 2, 1900, 362, Bacterium bordonii Chester, Manual of Determ Bact., 1901, 182.) Trom a cess of rappicker's disease which may have been anthray or malignant edema

Urobacillus beijerinekii Christensen. (Christensen, Ceut. f. Bakt., HAbt., 27, 1910, 357; Bacillus beijerinekii De Rossa, Microbiologia Agraria e Technica, 1927, 646) From humus. Utilizes urca.

Urobacillus jalschii Söhngen. (Söhngen, Cent f. Bakt, 11 Abt., 25, 1909, 93; Bacillus jalschii De Rossi, Microbiologia Agraris e Technica, 1927, 616.) From garden earth. Utilizes urea.

Urobacillus miqueln Beijerinek, (Cent. f. Bakt., 7, 1901, 47). From garden earth. Libinus (Handb. f. landwirtsch. Bakt., 1919, 459) regards this as belonging to the genus Proteus.

Urobacilius schütenbergii I and II Majuel (Miquel, Ann de Mierograph, 6, 1893, 321 and 223; Bacillus schütenbergii Migula, Syst d Bakt, 2, 1000, 727) From sewage and river water. These my belong to Proteis (Löhnis, Handb. I landwirtsch, Bakt., 1910, 459).

Urobacterum acrophilum Rubentschik. (Cent f Bakt, II Abt, 66, 1925, 175.) From salt water, Lake Liman near Odessi.

Urobactersum citrophilum Rubentschik. (Cent f Bakt., II Abt , 66, 1925, 172) From black mud and salt water, Lake Liman near Odessa.

Viscobacterium tactis foctidum Laxa. (Cent. I Bakt, II Abt., 95, 1936, I30.) From milk having a fetid odor

## APPENDIX TO SUBORDER EUBACTERHNEAE

Record of species and synonyms discovered too late to be entered in the main body of the text. Arranged alphabetically by genera.

Acetobacter aceti (Kutzing) Berjerinck syn. Bacterium aceticus Chester, Ann. Rept. Del. Col. Agr Exp. Sta., 9, 1897, 77.

Acetobacter acetosum Bergey et al. syn. Ulvina acetosa Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 75,

Acctobacter ascendens Bergey et al. syn Ulvina ascendene Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 75.

Acetobacter diversum Humm. (Duke Univ. Marine Lab , North Carolina, Bull. 3, 1946, 63.) From sea water. Beaufort, North Carolina and marioe algae, Miami, Florida. Digests agar.

Acciobacter mobile Tosić and Walker. (Jour of Brewing, 50, 1944, 296.) From bottled sle.

Acetobacter pasteurranum (Hansen) Beijerinck syn Bacillus pasteurianum Flugge, Die Mikroorganismen, 2 Aufl., 1886, 314, not Bacillus pasteurianus Lehmann and Neumann, Bakt. Diag. 4 Aufl , 2, 1907, 82, Ulvina pasteuriana Pribram, Klassifikation der Schizomyceten. Leipzig und Wien, 1933, 76.

Acetobacter potens Humm Univ. Marine Lab , North Carolina, Bull. 3, 1946, 63.) From intertidal sand, Beaulort, North Carolina. Digests agar

Acetobacter rancens Beijerinek syn Ulvina rancens Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 76

Acetobacter singulare Humm (Duke Univ. Marine Lab , North Carolina, Bull. 3, 1916, 62 ) From sen water, Beaufort, North Carolina Digests agar

Acetobacter xylinum (Brown) Holland Bacillus xylinus Trevisan, I generi e le specie delle Batteriacee, 1889, 16; Uleina zylina Pribram, Kla . 4 der Schizomyceten, Leipzig und Wien, 1933, 76.

Achromobacter caseinscum (Jour. Bact., 16, 1928, 38.) From a solution of sodium caseinate. Polar flagellate. Possibly a strain of Pseudomonus fluorescens Migula that had lost the power of forming pigment.

Achromobacter nijibetzui Takeda. (Cent. f. Bakt., II Abt., 94, 1936, 48) From diseased salmon eggs. Not found to be virulent. A polar-flagellated, Gram-negative, yellow chromoges, presumably belonging in the genus Xanthomonas.

Actinobacellus actinomycetemcomitans Topley and Wilson syn. Bacillus actinomycetemcomitans Rosebury, Bact Rev., 8, 1944, 205.

Aerobacter tiquefaciens Beijerinch. (Cent f. Bakt., II Abt., 6, 1900, 199; not Aerobacter liquefaciens Grimes and Hennerty, Sei Proc. Roy. Dublin Soc., (N.S.) 20, 1931, 93.) From mud and water in awamps. Monotrichous, otherwise like Aerobacter cloacae This may have been a species of gas-forming Pseudomonas.

Aerobacter tartarnorum. Nijdam. (Thesis, Leiden, 1907.) Decomposes dtartrates Probably identical with Aerobacter aerogenes (Vaughn, Marsh, Stadtman and Cantino, Jour. Bact , 55, 1946, 324)

Alcaligenes marshallis Bergey et al. ayn Bacterium marshalli Buchanan and Hammer, Iona Sta Coll Agr. Exp. Sta., Res. Bull. 22, 1915, 272.

Alcaligenes viscosum Weldin syn Plocamobactersum riscosum Prihram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 79.

Ascococcus buccalis Miller. (Die Mikroorganismen der Mundhöhle, Leipzig.

7, 65) From the mouth.

Bacillus annulatus Wright Syn. Bacterium annulatus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta, 9, 1897, 105

Bacillus cubonianus Macchiati syn Bacterium cubonianus Chester, Ann. Rept Del Col. Agr Exp. Sta., 9, 1897, 132

Bacillus duplicatus Wright (Wright, Mem Nat Acad. Sci, 7, 1893, 457; Bacterium duplicatus Chester, Ann Rept Del Col Agr Exp. Sta., 9, 1897, 90) From Schujkill River water. Monotrichous

Bacillus fluorescens mulabilis Wright (Wright, Alem Nat Acad. Sci. 7, 1895, 449, Bacterium fluorescens mulabilis Chester, Ann. Rept. Del Col Agr. Exp Sta. 9, 1897, 120) From Schuylkill River nater.

Bacillus fluorescens nivalis Eisenberg syn. Bacterium fluorescens nivalis Chester, Ann Rept Del Col Agr. Exp Sta, 9, 1807, 120.

Bacillus hayducki Henneberg syn Plocamobacterium hayducki Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 77.

Bacillus influenzoides apis White (Jour Path and Bact, 24, 1921, 71) From intestine of hee Monotrichous Bacillus mesentericus aureus Winkler

syn Bacillus unalleri Chester, Man Determ Bact, 1901, 256

Bacillus pabuli acidi II Weiss syn Plocamobacterium pabuli Pribrsm, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 78

Bacillus taginae Kruse syn Bacterium taginae Chester, Ann Rept Del Col Agr Exp Sta. 9, 1897, 67

Bacillus irrid-lufens Trevisan (Grungelber Bacillus, Essenberg, Bakt. Dag, 1 Aufl., 1886, 10, Trevisan, 1 generic le apecie delle Batternaces, 1889, 19) From water. This probably was the same as Bacillus fluorescens Trevisan, bid., 19 and Pseudomonus fluorescens Migula Bacillus wortmannii Henneberg syn. Plocamobacterium wortmanni Pribrsm, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 79.

Bacterium granulosum Lehmann and Neumann syn. Plocamobacterium granulosum Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 77.

Bacterium lipolyticum Huss syn. Kurthia lipolyticum Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 75

Bacterium orleanense Henneberg syn. Ulvina orleanensis Pribram, Klassifikation der Schizomyesten, Leipzig und Wien, 1933, 75

Bacterium zylinoides Henneberg syn Ulvina zylinoides Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 76.

Brucella byzantinea (Montsouris) Pribram (Coccobecterum byzantineum Montsouris, quoted from Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 67, Pribram, idem.)

Brucella cocciformis (Jaiser) Pribram. (Bacterium cocciforme Jaiser, quoted from Pribram, Klassifikation der Selugomyceten, 1933, 67, Coccobacterium thermophilum Negre, Compt. rend. Soc. Biol., Paris, 75, 1913, 814 and 867; Pribram, idem.) From sputum

Chlorobacterium lactis Guillebeau (Landw Jahrb. d. Schweiz 4, 1890, 32) From the udder of cows with mastitis Produces a green pigment Presumably identical with Presudomonas aeruginasa Migula The type species of the genus Chlorobacterium Guillebeau

Chromobacterum chocolatum Knutsen (Quoted Iron Lasseur, Dupar-Lasseur and Mejenon, Travaux du Lab de Microbiol, Fae Pharm de Naney, Fasc XIII, 192-33-41, 1944, 161, 187, 293, and 131 3 Isolated by M. II. Knutsen, State Coll., Pennsylvania Source not known Dull violet with brown tinge. Dissociates into a violet and an orange strain (Chromovacterium orangium Knutsen, loc. cit., 294).

Chromobacterium iodinum Davis, (Davis, Cent. f. Bakt., 11 Abt., 160, 1939, 273; also see Clemo and Mellwain, Jour. Chem. Soc., Pt. 1, 1933, 479; Tseudomonas iodinum Tobie and Pseudomonas etemo Tobie, Bull. Assoc. des Diplômés de Microbiol., Fac. Pharm. Nancy, No. 18, 1939, 16.) From plate inoculated with milk. This non-motile organism does not have the characters of Chromobacterium seusu stricto so that this species is retained with Bacterium for the present.

Coccus cumulus minor Black. (Trans. Ill. State Dental Soc., 23, 1886, 192.) From the mouth.

Corynebacterium hemolyticum Mac-Lean, Liebow and Rosenberg. (Jour. Inf. Dis., 79, 1946, 69). From infections among American soldiers and natives in the South and West Pacific. Similar in many ways to Corynebacterium pyogenes and C. ovis.

Corynchaetersum piriforme lloning. (Cent. f. Bakt, II Abt., 57, 1913, 383.) From tobacco plants in Sumatra.

Diplococcus aquatilis Vaughan. (Amer. Jour. Med. Sci., 104, 1892, 184.) From water.

Diplococcus glycinephilus Cardon and Barker. (Jour Bact, 52, 1916, 629) From marine mud

Diplococcus luteus Adametz and Wichmann (Adametz and Wichmann, Die Bakterien der Trink- und Nutzwässer, Mitt. Ocst Versuchsstat. f Brauerei u. Mälterei, Heft 1, 1885, 49, Planecoccus luteus Migula, Syst. Bakt. 2, 1900, 271) From water.

Escherichia Castellani and Chalmers syn Colibacter Pestana and Andrade, Ann Paulistas de Med e Cir, 59, 1910, 462.

Excherichia coli Castellani and Chalmers syn. Colibacter commune Pestann and Andrade, loc. cit

Flavobacterium harrisonis Bergey et al

syn. Bacillus harrisonii Buchanan and Hammer, Iowa Sta. Coll. Agr. Exp Sta., Res. Bull. 22, 1915, 257.

Flavobacterium tabidum Kimata (Cent. f. Bakt., II Abt., 105, 1942, 120) From spoiled semi-dried fish (Trachurus japonicus). Polar flagellate.

Fusiformis grandis Grassé. (Compt. rend. Soc. Biol., Paris, 94, 1925, 101; Arch. Zool. Expér. et Gén., 25, 1926, 463.) From the surface of the body of a flagellate (Polymastıx melolonthae), in the intestine of Inruae of beetles and tiputids, possibly also free in the intestine of the insects.

Tusiformis legeri Grassé. (Compt. rend. Soc. Biol., Paris, 94, 1920, 1914, Arch. Zool. Expér. et Gén., 65, 1924, 467.) From the surface of the body of a flagellate (Polymastiz legeri) and in the intestine of diplopouls.

Fustformis laphonosadis Grassé. (Compt. rend. Soc. Biol., Paris, 94, 1926, 1915, Arch. Zool. Ryper. et Gen, 65, 1926, 468.) Tran the surface of the body of a flagellate (Laphomonas striat) and in the intestine of cockranters)

Fusiformis melolonihae Grassé (Compt. rend. Soc. Biol., Paris, 81, 1926, 1014; Arch. Zool. Exptr. et Gén., 65, 1926, 465.) From the suriace of the body of a flagellate (Polymaniic melolonihae) and in the intestine of larvae of beetles and tipulids.

Gluconoacetobacter cerinus Takahashi and Asai. (Cent. f. Bakt., H Abt., 93, 1936, 252.) From fruits

Gluconoacriobacter liquefaciens Takshashi und Asai, doc. cit. From fruits.
Gluconoacrobacter roscus Takshashi und Asai. (Bacterium industrium Asr. hoshigali Takshashi and Asai, Cent. f. Bakt., 11 Abt., 52, 1930, 400; Bacterium hoshigali var. gluctronicum I Takshashi and Asai, rbid., 57, 1933, 383; Takshashi and Asai, rbid., 57, 1933, 232. From dired prezimmons (hoshigali).

Gluconobacter liquefaciens And (Jour Agr Chem Soc. Japan, 10, 1931, 621 and 11, 1935, 50, see Cent f. Bakt., II Abt., 95, 1936, 248.) From fruits

Jodococcus magnus Miller. (Deutsche med Wchnschr., 14, 1888, 612.) From the mouth. The type species of the genus Jodococcus (syn. Iodococcus) Miller

Jodococcus partus Miller (ibid , 612) From the mouth.

Lactobocillus bulgaricus Holland gyn Baclerium bulgaricum Buchanan and Hammer, Iowa Sta. Agr Evp Sta., Res. Bull. 22, 1915, 250.

Lactobacillus buchners Bergev et al. syn Ulvina buchneri Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 75.

Lactobacillus delbruecksi Benjerinek syn Ulvina delbruecki Pribram, loc. ett , 75, Plocamobacterium delbruecki Pribram, ibid., 77.

Lactobacellus helyeticus Holland syn Plocamobacierium casei Pribram, loc. cit, 77; Plocamobacterium helicticum Pribram, 1bid., 78.

Lactobacillus pastorianus Bergev et al. syn. Plocamobacterium pastorianum Pribram. loc. cit., 78

Laciobacillus pentoaceticus Fred, Peterson and Davenport syn Plocamobaciersum penioaceiscum Pribram, loc. cit , 78.

Lactobacellus plantarum Holland syn Ulvina cucumeris fermentati Pribram, loc cit., 75.

Laciobacillus lactie Olsen-Sopp. (Cent. f Bakt , II Abt , 35, 1912, 14 ) From ropy milk

Leptotrichia Trevisan partial syn Leucothrix Oersted, De regionibus

marinis, 1844, 44. Listeria monocytogenes Pirie syn. Brucella monocytogenes Pribram, Klassifikation der Schizomyceten, Leipzig und

Wien, 1933, 68 Mammococcus gorini (Quoted from L. Gorini, Enzymologia, 10, 1942, 102)

From the udder Micrococcus afermenians Castellani

(Proc. Soc. Exp Biol. and Med , 25, 1928,

536; also see Jour, Trop Med, and Hyg. 55, 1932, 372) From an ulcerative lesion of the skin

Micrococcus albus var. maltigenes Dumais and Albert. (Quebec Laitier, 5 (2), 1946, 19.) From Richelieu cheese Regarded as an important ripening agent.

Micrococcus aquatilis Vaughan. (Vaughan, Amer. Jour. Med. Sci., 104. 1892, 190; not Micrococcus aquatilis Chester, Man Determ Bact , 1901, 88; not Micrococcus aqualilis Bolton, Ztschr. f Hyg., 1, 1886, 94.) From water

Micrococcus aquatilis albissimus von Rigler, (Hyg Rund, 12, 1902, 482) From bottled mineral waters

Micrococcus aquatilis albus Vaughan. (Vaughan, Amer. Jour. Med. Sci., 104, 1892, 182; not Micrococcus aqualilis albus Toporoff, Cent f Bakt , 15, 1893, 487.) From water.

Micrococcus aqualilis magnus Vaughan (Amer Jour Med Sci., 104, 1892, 182.) From water

Micrococcus aquivious ZoBell and Upham, (Bull, Scripps Inst. of Oceanography, Univ Calif., 5, 1944, 275) From sea water

Micrococcus cyaneus (Schroeter) Colin syn Bacterium cyaneus White, U. S. D.A., Bur. Entomol Tech Ser. Bull. 14, 1906, 16.

Micrococcus enteroideus Castellani (Proc. Soc Exp Biol. and Med , 25, 1928, 536, also see Jour. Trop. Med and Hyg , 55, 1932, 372.) From feces.

Micrococcus euruhalis ZoBell and Up bam. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 255) From sea water

Micrococcus griseus Winter syn. Bacillus griscus Trevisan, I genera e le specie delle Batteriacec, 1889, 18.

Micrococcus himonoi Kimata. (Cent f Bakt II Abt , 105, 1942, 116 ) From spoiled semi-dried fishes (Scomber 1aponicus and Trachurus japonicus) Resembles Micrococcus caseolyticus and M mucofaciens.

Micrococcus infimus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 262.) From marine bottom deposits.

Micrococcus laevulosinertis Castellani. (Proc. Soc. Exp. Biol. and Med., 25, 1928, 536, also see Jour. Trop Med. and Hyg., 55, 1932, 372.) From a case of stomatitis.

Micrococcus maripuniceus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1914, 261.) Sessile form found on slides submerged in sea water.

Micrococcus metentericus Castellani. (Quoted from Jour. Trop Med. and Hyg., 55, 1932, 372.) From case of ulcerative colitis.

Micracoccus moricolor Holmes and Wilson. (Jour. Bact., 49, 1945, 311.) From contaminated wounds. Produces a mulberry pigment on potato

Micrococcus myceticus Castellani. (Arch. Dermat. and Syphil., 18, 1923, 857.) From cases of pseudomycosis.

Micrococcus nexifer Miller. (Miller, Die Mikroorganismen der Mundhöhle, Leipzig, 1829, 65.) From the mouth, Probably Streptococcus brens according to Gondby (Mycology of the Mouth, London, 1903, 60).

Micrococcus pulatus Ravenel (Mem. Nat Acad. Sci. 8, 1896, 21.) From soil. Micrococcus pulmus Castellani. (Quoted from Jour. Trop. Med and Hyg., 55, 1932, 372.) From a case of glossitis.

Micrococcus rhodochrous Migula syn. Bacilius rhodochrous Dyar, Ann. N. Y. Acad. Sci. 8, 1895, 362, Bacterium rhodochrous Chester, Ann. Rept Del Col. Agr. Eyp. Sta., 9, 1897, 116) Dyar had the original Micrococcus rhodochrous culture from Krāl and felt as have others who have examined this culture that it is not a true Micrococcus.

Micrococcus sedentarius ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 266) Sessile form found on slides submerged in sea water.

Micrococcus sedimentcus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 265.) Sessile form found on slides submerged in sea water and in marine mud.

Micrococcus visicidus Castellani, (Proc. Soc. Exp. Biol. and Med., 25, 1923, 536; also see Jour. Trop. Med. and Hyg., 35, 1932, 372.) From an inflamed upper lip.

Microspira racillans Gickinors. (Cent. t. Bakt., II Abt., 50, 1920, 422.) From the pool in the Botanical Garden, Univ. Graz, Austria. Contains grains of sulfur.

Neisseria babesi Trevisan. (Bactérie do l'hémoglobinurie du hoeuf, Babes, 1883; Trevisan, I generi e le specie delle Batteriacee. 1889. 32.)

Neisseria lutea (Adametz) Trevisan. (Diplococcus luteus Adametz, 1887; Trevisan, I generi e le specie delle Batteriacce, 1883, 32.)

Neisseria micheli Trevisan. (Trachomcoccus, Michel, 1896; Trevisan, I generi e le specie delle Batteriacee, 1899, 32.)

Neisseria pharyngis syn. Micrococcus pharyngis Cruikshank and Cruikshank, Med. Res. Council Syst. of Bact., 8, 1931, 349.

Pacinia decipiens Trevisan. (Spirillum aus der Luft, Babes, Zischr. f. Hyg., 5, 1838, 183; Trevisan, I generi e le specie delle Batteriacee, 1889, 21.) From the nir.

Pacinia rabida Trevisan. (Spirillum bei Rabies, Babes, Ztschr. f. Hyg., 5, 1888, 181; Trevisan, I generi e le specie delle Batteriacce, 1889, 23)

Pectobacterium delphinin Waldee. (Ark, Phytopath., £8, 1938, 281; Waldee, Iowa State Coll. Jour. Sci., £9, 1945, 471.) Causes larkspur bacterial blight.

Phytomonas asplenii Ark and Tompkins. (Phytopath, 36, 1946, 769.) Causes leaf blight of bird's nest fern. Phytomonas maculifelium-gardeniae



Micrococcus infimus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 262.) From marine bottom deposits.

Micrococcus laevulosinertis Castellani. (Proc. Soc. Exp. Biol. and Med., 25, 1928. 536; also see Jour. Trop. Med. and Hyg., 85, 1932, 372.) From a case of stomatitis.

Micrococcus maripuniceus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 264.) Sessile form found on slides submerged in sea water.

Micrococcus metentericus Castellani. (Quoted from Jour. Trop. Med. and Hyg., 55, 1932, 372.) From case of ulcerative colitis.

Micrococcus moricolor Holmes and Wilson (Jour. Bact., 49, 1945, 311.) From contaminated wounds. Produces a mulberry pigment on potato.

Micrococcus myceticus Castellani, (Arch. Dermat. and Syphil, 18, 1928, 857.) From cases of pseudomycosis. Micrococcus nezifer Miller, (Miller,

Die Mikroorganismen der Mundhöhle, Leipzig, 1839, 65.) From the mouth. Probably Streptococcus brevis according to Goadby (Mycology of the Mouth, London, 1903, 60).

Micrococcus putatus Ravenel (Mem. Nat. Acad. Sci , 8, 1896, 21.) From soil. Castellani. Micrococcus putneus (Quoted from Jour Trop Med and Hvg., 35, 1932, 372) From a case of glossitis

Micrococcus rhodochrous Migula syn. Bacillus rhodochrous Dyar, Ann. N Y. Acad. Sci , 8, 1895, 362, Bactersum rhodochrous Chester, Ann Rept. Del. Col. Agr Exp Sta , 9, 1897, 116 ) Dyar had the original Micrococcus rhodochrous culture from Kral and felt as have others who have examined this culture that it is not a true Micrococcus

Micrococcus sedentarius ZoBelland Upham, (Bull. Scripps Inst of Oceanography, Univ. Calif , 5, 1944, 260) Sessile form found on slides submerged in sea water.

Micrococcus sedimentcus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 265.) Sessile form found on slides submerged in sea water and in marine mud.

Micrococcus visicidus (Proc. Soc. Exp. Biol. and Med., 25, 1928, 536; also see Jour. Trop. Med. and Hyg., \$5, 1932, 372.) From an inflamed upper lip.

Microspira vacillans Gicklhorn. (Cent. f. Bakt., II Abt., 50, 1920, 422) From the pool in the Botanical Garden, Univ. Graz, Austria. Contains grains of sulfur.

Neisseria babesi Trevisan. (Bactérie de l'hémoglobinurie du bocul, Babes, 1888; Trevisan, I generi e le specie delle Batteriacee, 1889, 32.)

Neisseria lutea (Adametz) Trevisan. (Diplococcus luteus Adametz, 1687; Trevisan, I generi e le specie delle Batteriacee, 1889, 32.)

Neisseria micheli Trevisan (Trachomococus, Michel, 1886; Trevissa, I generi e le specie delle Batteriacce, 1889,

Neisseria pharyngis syn. Micrococcus pharyngis Cruikshank and Cruikshank, Med. Res. Council Syst. of Bact, 8, 1931, 349.

Pacinia decipiene Trevisan. (Spirillum aus der Luft, Babes, Zischr. f. Hyg, 5, 1888, 183; Trevisan, I generi e le specie delle Batteriacec, 1889, 24) From the

Pacinia rabida Trevisan. (Spirillum bei Rabies, Bahes, Ztschr. f. Ifyg, 8, 1888, 181; Trevisan, I generi e le specie delle Batteriacee, 1889, 23.)

Waldec. delphinii Pectobacterium (Ark, Phytopath , 28, 1938, 281; Waldee, Iona State Coll. Jour. Sci., 19, 1945, 471) Causes larkspur bacterial blight.

Phytomonas asplenii Ark and Tomp-(Phytopath., 36, 1916, 760.) Causes leaf blight of bird's nest fern. Phytomonas maculifelium-gardeniae

Ark. (Phytopath , 56, 1946, 867.) From gardenia (Gardenia jasminoides). santhomonad.

Phytomonas suringae populans Smith. (Jour. Agr. Res., 68, 1944, 269.) Considered the cause of blister spot, a disease of apple.

Phytomonas washingtoniae Pine. (Phytopath., 55, 1943, 1203) From the Washington palm, Washingtonia filifera. A pseudomonad.

Pneumococcus flatescens Arloing. (Compt. rend. Acad. Sci., 109, 1889, 428 and 459.) From lesions of cattle having peripneumonia.

Pneumococcus guita ceres Arloing, loc. cit. From lesions of cattle having perippeumonia

Pneumococcus lichnoides Arloing, loc. cit. From lesions of cattle baying peripneumonia.

Pseudomonas aestumarina ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 269 ) A marine sedentary organism.

Pseudomonas allis (Griffiths) Migula syn, Bacillus allii Sternberg, Man of Bact., 1893, 629.

Pseudomonas ambigua (Wright) Chester syn Bacterium ambiguus Chester, Ann Rept. Del Col. Agr Exp. Sta., 9, 1897. 71.

Pseudomonas atlantica Humm. (Duke Univ Marine Lab . North Carolina. Bull 3, 1946, 58.) From seaweed (Gracilarra blodgettri') and beach sand. Digests agar

Pseudomonas aurea Migula syn. Bacterium fluorescens aureus Chester. Ann Rept. Del. Col. Agr Exp Sta . 9, 1897. 109.

Pseudomonas azotocena ZoBell and Upham (Bull, Scripps Inst. of Oceanography, Univ. Calif., 5, 1914, 260) From sea water and marine mud.

Pseudomonas beaufortensis Ilumm (loc cit, 58). From seawater, battom mud and on algae Digests agar.

Pseudomonas berolinensis Migula (Indigoblauer Bacillus, Clacssen, Cent.

f. Bakt., 7, 1890, 13, Bacillus berolinensis indicus Germano, Cent. f. Bakt., 12, 1892, 517; Bacillus indigoferus Zimmermann, Bakt, unserer Trink- u Nutzwässer, Chemnitz, 2, 1894, 16, not indicated as being the same as Bacillus indigoferus Voges, Cent. f. Bakt . 14, 1893, 307, Bacillus indigonaceus Schneider, Arb bakt. Inst. Karlsruhe, 1, Heft 2, 1894, 228; Migula, in Engler and Prantl, Die naturi. Pflanzenfam., 1. 1a. 1895. 29; Bacterium indigonaceum Lehmann and Neumann, Bakt, Diag . 1 Aufl., 2. 1896, 267; Bacterium berolinensis indicus Chester, Ann Rept. Del. Col. Agr. Evp. Sta , 9, 1897, 118 ) From Spree River water.

Pseudomonas butyr: Migula syn. Bacterium butyri fluorescens Chester, Ann. Rept Del. Col. Agr. Evp. Sta., 9, 1897. 120.

Pseudomanas centrifugans (Wright) Chester. (Bacillus centrifugans Wright, Mem. Nat. Acad. Sci., 7, 1895, 462, Bacterrum centrifugans Chester, Ann. Rept. Del. Col Agr. Evp. Sta., 9, 1897, 95; Chester, Man. Determ Bact., 1901, 312.) From water.

Pseudomonas coadunata Chester syn Bacterium coadunatus Chestor, Ann. Rept. Del Col. Agr. Exp Sta , 9, 1897, 90.

Pseudomonas ecenobios ZoBell and Upham, (Bull, Scripps Inst. of Oceanography, Univ Calif., 5, 1944, 272.) From film of marine fouling organisms.

Pseudomonas cohacrea (Wright) Chester, nat Bacillus cohaerens Gottheil, Cent f. Bakt., 11 Abt , 7, 1901, 458; Bacterium cohaereus (sic) Chester. Ann. Rept Del, Col. Agr. Evp Sta., 9, 1897,

Pseudomonas coli communis Conn. Esten and Stocking. (Storrs Agri, Exp. Sta , Cann , 18th Ann, Rept. for 1906, From cheddar cheese Bacillus coli communis except that it has a single, long flagellum.

Pseudomonas conrera Chester syn. Bacterium fluorescens contexus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 123.

Pseudomonas corallina Humm (loc. cit., 59). From marine algae of all common species at Beaufort, Nor. Car. Digests agar.

Pseudomonas delabens (Wright) Chester syn. Bacterium delabens Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9,

1897, 97.

Pseudomonas eisenbergii Migula syn. Bacterium fluorescens non-liquefaciens Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 124.

Pseudomonas elongata Humm (loc. cil., 60). From intertidal sand, Atlantic Beach, Nor. Car. Digests agar.

Pseudomonas enalia ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 254.) From sea water and marine mud.

Pseudomonas fairmountensis (Wright) Chester syn. Bacterium fairmountensis Chester, Ann. Rept Del. Col. Agr. Exp. Sta., 9, 1897, 90.

Pseudomonas felthami ZoBell and Upham. (Bull. Scripps Inst of Oceanography, Univ. Calif, 5, 1944, 267.)
From marine mud

Pseudomonas fimbriata (Wright) Chester syn. Bacterium fimbriatus Chester, Ann Rept Del. Col. Agr. Exp. Sta., 9, 1897, 95

Pseudomonas floridana Humm (loc. cit., 60) From algae and beach sand at Miami, Fla, and Beaufort, Nor. Car Digests agar.

Pseudomonas fluorescens Migula syn. Bacterium fluorescens liquefaciens Chester, Ann. Rept. Del. Col Agr Exp Sta., 9, 1897, 120

Pseudomonas foliacea Chester syn. Baclerium fluorescens foliaceus Chester, Ann. Rept. Del. Col Agr Exp Sta., 9, 1897, 122.

Pseudomonas geniculatus (Wright) Chester. Bacillus geniculatus Wright, not Bacillus geniculatus DeBary, Inaug Diss., Strassburg, Leipzig, 1885; not Bacillus geniculatus Trevisan, I generi e le specie delle Batteriacee, 1889, 16; syn. Bacterium geniculatus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 95.

Pseudomonas humicola Bersteyn. (Arb. bakt. Inst. Karlsruhe, 5, 1903, 97.) From soil.

Pseudomonas hypothermis ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 276) From marine bottom deposits.

Pseudomonas incognita Chester syn. Bacterium fluorescens incognitus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 122.

Pseudomonas indoloxidans Gray. (Proc. Roy. Soc. London, B, 102, 1928, 263.) From soil from Italian Tyrol.

Pseudomonas indigoferus (Voges) Migula (Bacillus indigoferus Voges, Cent.

I. Bakt., 14, 1893, 307; Bacterium indigoferus Chester, Ann. Rept. Del. Col. Agr.
Evp. Sta., 9, 1807, 118; Migula, Syst. d.
Bakt., 2, 1900, 950) From Kiel tap
water (Voges); from Delft ditch water,
mud and garden soil (Edazari-Voleni,
Arch. I. Mikrobiol., 10, 1939, 357). Some
authors regard Voges' organism as
identical with Chaesan's indigo blue
bacıllus, see Pseudomonas berolinensis.
Pseudomonas ındigoferus var. immobits Elazari-Volenii. (Arch. f. Mikrobits Elazari-Volenii. (Arch. f. Mikrobits Elazari-Volenii. (Arch. f. Mikrobits I. (10, 1939, 350.) From ditch mud.

bitis Elazari-Volcani. (Arch. f. Aikrobiel, 16, 1939, 350.) From ditch mud. See Lehmann and Neumann (Bakt Diag, 1 Aufl., 2, 1896, 267) who also had a non-motile strain (Bacterium indigenaceum) from Krall which they considered identical with Claessen's indige blue bacilius.

Pseudomonas mertia Ilumm (loc. cit., 61) From intertidal sand, Atlantic Beach, Nor. Car. Digests agar.

Pseudomonas iris Migula syn. Bactlus fluorescens crassus Kruse, in Flusge, Dre Mikroorganismen, 3 Aufl., 2, 1896, 211, Bacterium fluorescens crassus Chester, Ann Rept. Del. Col. Agr. Lyp. Sla., 9, 1897, 134; Bacterium iris Chester, idem, 187.) Trom sputum.

Pseudomonas jaegeri Migula syn. Bac-

terium proteus fluorescens Chester, Ann. Rept. Del. Col. Agr. Exp. Sts , 9, 1897, 119, and Bacillus uringe Chester, Man Determ, Bact , 1901, 263

Pseudomonas javanica (Eiikmann) Migula syn. Bacterium pavaniensis Chester, Ann. Rept. Del. Col. Agr. Evp Sta ,

9, 1897, 111,

Pseudomonas liquida Chester. (Bacillus liquidus Frankland and Frankland. Ztschr f. Hyg., 6, 1889, 382; Chester, Man. Determ. Bact., 1901, 311, Achromobacter liquidum Bergey et al., Manual, 1st ed., 1923, 145 ) From water. Originally described merely as motile. Chester recognizes the species as polar flagellate and lists Bacillus liquefaciens communis Sternberg and Bacillus aquatilis communis Kruse as synonyms

Pseudomonas longa Migula syn. Bacterium fluorescens longus Chester, Ann. Rept. Del Col. Agr. Exp. Sta , 9, 1897, 124.

Pseudomonas macroselmis Migula syn. Bacillus fluorescens putidus Chester, Ann. Rept Del Col. Agr. Exp Sta., 9. 1897, 121.

Pseudomonas marinopersica Zo Bell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 275.) From marine bottom deposits

Pseudomonas melochlora (Winkler and Schrotter) Migula syn. Bacterium melochlorus Chester, Ann. Rept. Del Col Agr. Exp Sts., 9, 1897, 120, see abst in Cent. f Bakt., 9, 1891, 700

Pseudomonas membranula ZoBell and Upham. (Bull Scripps Inst. of Oceanography, Univ Calif., 5, 1944, 270) Sessile form found on slide submerged ın sca.

Pseudomonas minutissima Migula syn Bactersum fluorescens minutissimus Chester, Ann Rept. Del. Col Agr. Exp Sta.,

9, 1897, 120

Pseudomonas monadiformis (Kruse) Chester syn. Bacterium monadiformis Chester, Ann Rept Del Col, Agr. Exp. Sta., 9, 1897, 69; Racterium cols mobilis Chester, sbid , 69

Pseudomonas multistriata (Wright) Chester syn. Bacterium multistriatus Chesler, Ann. Rept. Del. Col Agr Exp. Sta., 9, 1897, 90.

Pseudomonas nebulosa (Wright) Chester syn. Bacterium nebulosus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897.93

Pseudomonas neritica ZoBell and Upham. (Bull, Scripps Inst. of Oceanography, Univ Calif. 5, 1914, 255.)

From sea water and marine mud. Pseudomonas nexibilis (Wright) Chester syn. Bacterium nexibilis Chester. Ann. Rept. Del. Col. Agr. Exp. Sta , 9,

Pseudomonas obscura ZoBell and Upham (Bull, Scripps Inst. of Ocean-

ography, Univ. Calif., 5, 1944, 274) From marine bottom deposits Pseudomonas oceanica ZoBell and Up-

bam. (Bull, Scripps Inst, of Occanography, Univ. Calif., 5, 1944, 266.) From marine mud.

Pseudomonas ochracea (Zimmermann) Chester syn. Bactersum ochraceus Chester, Ann Rept. Del Col. Agr Exp Sta., 9, 1897, 101,

Pseudomonas or alis Chestersyn. Bactersum fluorescens ovalis Chestor, Ann. Rept. Del Col. Agr Exp Sta., 9, 1807, 123

Pseudomonas pallescens Migula syn Bacterium viridis pallescens Chester. Ann, Rept Del Col. Agr. Exp. Sta., 9, 1897, 124

Pzeudomonas perfectomarinus ZoBell and Upham, (Bull, Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 277.) From sea water and marine mud

Pseudomonas periphyta ZoBell and Upham (Bull Scripps Inst. of Oceanography, Univ Calif., 5, 1914, 276) Sessile form found in film of marine fouling organisms.

Pseudomonas phosphorescens (Fisher) Bergey et al. syn Pasteurella phosphorescens Trevisan, I generi e le specie delle Batteriacce, 1889, 21; Bacillus phosphorescens indicus Lisenberg, Bakt.

Diag., 3 Aufl., 1891, 123; Vibrio indicus Lehmann and Neumann, Bakt. Diag., · 1 Aufl., 2, 1896, 341; Bacterium phosphorescens indieus Chester, Ann. Rent. Del. Col. Agr. Exp. Sta., 9, 1897, 120; Photobacter indieum Beijerinck, Proc. Seet. Sci., Kon. Akad. v. Wetensch., Amsterdam, 3, 1900, 352; Microspira phosphorescens Chester, Man. Determ. Baet., 1901, 333; Bacillus indicus Beijerinek, Folia Mikrobiologica, Delft, I, 1912, 1. Beijerinek (loc. cit., 1900) diseusses two variants of this species: Photobacter indieum var. obscurum and Photobacter indicum var. Later, Beijerinck (loc. cit , 1912), in discussing mutants of this species, proposes the species names Bacillus indicus parrus, Bacillus indicus semiobscurus and Bacillus indicus obscurus.

Pseudomonas piscora Hanzawa and Takeda. (Jozogaku Zasshi, Osaka, Japan (Jour. of Zymology), 9, 1931, 571; quoted from Takeda, Cent. f Bakt., II Abt., 94, 1930, 46) From discased sal-

mon eggs.

Pseudomonas pleomorpha ZoBell and Upham. (Bull Scripps Inst. of Oceanography, Univ. Calif, 5, 1944, 275.) From marine bottom deposits.

Pseudomonas pullulans (Wright) Chester syn. Bacterium pullulans Chester, Ann. Rept. Del. Col. Agr. Exp.

Sta , Ø, 1897, 105.

Pseudomonas puris Patrick and Werkman. (Proc. Iowa Acad. Sci., \$7, 1930, 57.) From a typhoid-like infection of snakes.

Pseudomonas ribicola Bohn. (Jour. Agr Res, 73, 1946, 288) From the native currant, Ribes aureum

Pseudomonas riboflavinus Foster. (Jour. Bact., 47, 1944, 30.) Oxidizes riboflavin to lumichrome. From ribo-

flavin-rich soil

Pseudomonas roseola Humm (loc. cit,
62) From intertidal sand, Atlantie
Beach, Nor Car. Digests agar

Pseudomonas rugosa (Wright) Chester syn. Bacterium rugosus Chester, Inn. Rept Del. Col. Agr. Exp. Sta., 9, 1897, 122.

Pseudomonas schuylkilliensis Chester syn. Bacterium fluorescens schuylkilliensis Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 119

Pseudomonas scissa (Frankland and Frankland) Migula syn. Bacterium scissus Chester, Ann. Rept. Del Col. Agr.

Evp Sta., 9, 1897, 143.

Pseudomonas sessilis ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 259.) Sessile form found on solid surfaces submerged in the sea.

Pscudomonas sinuosa (Wright) Chester syn. Bacterium sinuosus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897,

69

Pseudomonas smaragdina Migula syn. Bacterium smaragdino foetidus Chester, Ann. Rept. Del. Col. Agr. E.p. Sta. 9, 1897, 119; and Bacillus smaragdinus Chester, Man. Determ. Bact., 1901, 253

Pseudomonas sterotropis ZoBell and Upham. (Bull. Seripps Inst. of Occanography, Univ. Calif., 5, 1944, 272) From a film of marine foultag organisms Pseudomonas striata Chester syn Bacterium striatus viridis Chester, Ann Rept. Del. Col. Agr. Evp. Sta. 9, 1897,

123. Pseudomonas syncyanea Migula syn. Bacterium syncyanus (sic) Schroeter, Beitr. 2. Etol. d. Pflanz., 1, Heft 2, 1872. 126 and Bacterium cyanogenum Zopf, Die Spathpilie, 2 Aufl., 1884, 50; may be in 1 Aufl.

Pseudomonas synzantha (Ehrenberg) Holland. (Vebrio synzanthus Ehrenberg, Verhandl, d. Berl. Akad, 1810, 202, Vibroo zanthogenes Fuchs, Magazin I. d. ges. Therheilk., I., 1841, 193; Bacterum Charles (Color Bolitage)

· 120;

terium synzanihum Bergey et ai, Manual, 1st ed, 1923, 102; Holland, Jour Bact, 5, 1920, 220) Bergey et al. (Manual, 1st ed., 1923, 102) give Bacterium zauthogenes as a synonym From milk and cream. Polar flagellate (Hammer, personal communication). See Hammer, Res. Bul 20, Iowa Agr. Evp. Sta., 1915, Ior a description of this organism

Pseudomonas tenuis Migula syn. Bacterium stuorescens tenuis Chester, Ann. Rept Del. Col. Agr. Exp. Sta., 9, 1897, 124.

Pseudomonas turcosa Migula syn. Turkisfarbener Bacıllus, Tataroff, Inaug. Diss., Dorpat, 1891, 52.

Pseudomonas tadosa ZoBell and Upham. (Bull. Stripps Inst. of Oceanography, Univ Calif, δ, 1944, 263) From sea water and marine bottom

Pseudomonas virescens (Frick) Migula syn Bacterium virescens Chester, Ann. Rept. Del. Col. Agr. Exp. Sta, 9, 1897, 124.

Pseudomonas tiscosa (Frankland and Frankland) Migula ayn. Bacterium viscosus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta. 9, 1897, 145, not Bacterium viscosum Weldin and Levine, Abst. Bact. 7, 1923, 16

Pseudomonas xanthochrus ZoBell and Upham (Bull Scripps Inst. of Oceanography, Univ. Calif., 5, 1914, 279) From marine bottom deposits.

Rambacterium alactolyticum Prévot and Taffanel. (Ann Inst. Past , 63, 1912, 259) From an extemplegmon of the mixillary lame. Salmonella atherton Ferris, Hertzberg and Atkinson (Med. Jour. Australia, 32, 1945, 368.) From 29 cases of gastroenteritis in an army hospital

Salmonella typhosa (Zopf) White syn Bacillus typhicus Cabral and Da Rocha, I Trabalhos do Cabinette de Microbiologia; abst in Ann de Micrographie,

2, 1889-1890, 205

Sarcina pelagia ZoBell and Upham (Bull. Scripps Inst. of Oceanography,

(Bull. Seripps Inst. of Oceanography, Umv Calif, 8, 1944, 279) From sen water and marine bottom deposits Serratia fuchsina Bereev et al. syn.

Proteus fuchsinus Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 73

Serratia indica (Eisenberg) Bergey et al syn Bacellus indicus ruber Flugge, Die Mikroorganismen, 2 Aufi, 1886, 255; Bacterium indicum Crookshank, Manual, 1887, 240

Spiritum pareum Esmarch (Cent. f. Bakt, I Abt., Orig, 32, 1902, 565; also see Zettnow, 15id, 78, 1916, 1)

also see Zettnow, thid, 78, 1916, 1; From decaying organic matter

Spirillum sputigenum Flugge (Lewis, Lancet, Sept 20, 1884; Flugge, Die Mikroorganismen, 2 Auff, 1886, 387, Pacinia lewisi Trevian, I generi e le specie delle Batteriacce, 1889, 21) From sputum.

Staphylococcus activus Provot and Taffanel. (Ann. Inst Past, 71, 1915, 102.) From puerperal septicemia. Anaerobic.

Staphylococcus citreus duodenalis Gessner. (Arch f. Hyg, 9, 1889, 136) From the human duodenum.

Staphylococcus magnus Black. (Trans III. State Dental Soc, 22, 1886, 188) From the mouth.

Staphylococcus medius Black (Trans. Ill. State Dental Soc, 22, 1886, 190) From the mouth.

Staphylococcus pyogenes bovis Lucet (Ann Inst. Past., 7, 1893, 327.) From bovine abscesses

Staphylococcus uscusus Goadby.

(Mycology of the mouth, London, 1903. 172.) From the mouth.

Streptobacterium dextranicum Perguin. (Jour. Microbiol. and Serol., 6, 1940. 226.) Produces slime from sucrose solutions.

Streptococcus aauatilis Vaughan. (Amer. Jour. Med. Sci., 104, 1892, 184.) From water.

Streptococcus liquefaciens Frankland and Frankland, (Phil. Trans Roy. Soc. London, 178, B, 1888, 261.) From air. After the section covering Strep. tococcus liquefaciens Sternberg emend. Orla-Jensen was in page proof, it was discovered that Frankland and Frankland had discovered and named a liquefying streptococcus earlier than Sternberg, The Franklands described this species as producing a vellow pigment.

Streptococcus pyogenes duodenalis Gessner. (Arch. f. Hyg., 9, 1889, 132.) From the human duodenum.

Streptococcus taette (Olsen-Sopp) Buchanan and Hammer. (Bacterium lactie longi Troils-Petersson, Ztschr. f. Hyg., 32, 1899, 361 and Milchzeitung, 28, 1899, 438: Streptobacillus tactie Olsen-Sopp. Cent. f. Bakt., II Abt , 53, 1912, 9; Buchanan and Hammer, Iowa Sta. Coll Agr. Exp Sta., Res Bull. 22, 1915, 277.) Probably the characteristic organism of Swedish ropy milk. Olsen-Sopp (loc cit.) misquotes Troils-Petersson's name as Bacillus acidi lactis longus (see Troili-Petersson, Cent f. Bakt , II Abt , 38, 1913, 1)

Thiospira agilissima (Gieklhorn) Bavendamm. (Spirillum agılissimum Gicklhorn, Cent. f. Bakt , II Abt , 50, 1920, 418; Bavendamm, Die farblosen und roten Schwefelhakterien, Pflanzenforschung, Heft 2, 1924, 116 ) From the pond in the Annen Castle Park, Graz. Austria. Contains grains of sulfur.

Thiospira elongata Perfiljev (Ber. d Sapropel Komm. Petrograd, 1923, 56) From mud containing H2S

Thiospira propera Hama. (Jour. Sc.

Hiroshima Univ., Ser. B, Bot., 1, 1933, 157; abst. in Cent. f. Bakt., II Abt., 91, 1934, 200.)

Thiospira sulfurica Issatchenko (Biological observations on the sulfur bacteria (Russian), about 1927, 16 pp)

Vibrio adaptatus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 258.) From sea water and marine sediments.

Vibrio agarlyticus Cataldi. (Rev. d Inst. Bact. (D.N.H.), Buenos Aires, 9, 1940, 375.) From activated sludge

Digests agar. Vibrio albensis Lehmann and Neumann syn. Vibrio dunbari Holland, Jour. Bset., 5, 1920, 226; probably Vibrio phosphorescens Jermoljewa, Cent. f. Bakt , I Abt , Orig., 100, 1926, 170; act

Vibrio phosphorescens Holland, loe. cit. Vibrio algosus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 257.) Associated with marine kelp.

l'ibrio amphibolus Trevisan. (Babes, Ztschr. f. Hyg., 5, 1888, 183; Trevisan, I generi e le specie dello Batteriacec, 1889, 23.) Apaerobe.

l'ibrio aridus Humm (Duke Univ Marine Lab., North Carolina, Bull. 3, 1946, 54.) From intertidal sand, Beaufort, North Carolina. Digests agar

Vibrio choleroides α and β Bujwid syn. Bacterium, choleroides Chester, Ann. Rept. Del. Col Agr. Evp. Sta., 9, 1897, 131.

Vibrio costicolus Smith and Vibrio costicolus var. liquefaciens Smith. (Roy. See Queensland, Proc. for 1937, 49, 1938, 29 and 32.) From tainted ribs of bacon and tank brines in bacon factories Active growth in 4 to 15 per cent brines

Vibrio euprima, Vibrio yasakii, Coccobacillus tolega and Coccobacillus sepiola Majima, Sci 1 Kwai- Med. Jour. 50, 1931, 41-67; see Warren, Jour. Bact., 49, 1945, 543) Phosphorescent bacteria.

Vibrio fortis Humm (loc. cit, 55). From seaweed (Gracilaria conferioides). Digests agar.

Vibrio frequens Humm (loc. cit., 56) From marine algae (Cladophoropsis, Laurencia voitei, etc.) Digesta agar.

Vibrio halonitrificans Smith. (Roy. Soc. Queensland, Proc for 1937, 49, 1938, 29.) From tank brines in bacon factories. Active growth in 4 to 10 per cent brines

Vibrio haloplanktis ZoBell and Upbam (Bull Scripps Inst. of Ochanography, Univ. Calif., 5, 1944, 261) Sessile form found associated with marine phytoplankton

Vibrio hyphalus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif.; 5, 1944, 277.) From marine bottom deposits.

Vibrio marinagilis ZoBell and Upbani. (Bull. Soripps Inst of Oceanography, Univ. Cahf, 5, 1944, 264.) From sea water and marine mud.

Vibrio marinoflavus ZoBell and Upham. (Bull. Scripps Inst of Oceanography, Univ. Calif., 5, 1944, 258)
From sea water.

Vibrio marinofulvus ZoBell and Upliam (Buil Scripps Inst. of Oceanography, Univ. Calif, 5, 1944, 262) From sea water.

Vibrio marinopraesene ZoBell and Upham (Bull. Scripps Inst of Oceanography, Univ. Calif., 5, 1944, 256) From sea water.

Vibrio marinorulgaris ZoBell and Upham. (Bull. Scripps Inst of Oceanography, Univ. Calif. 5, 1944, 261) From sea water

Vibrio notus Humm (loc cst , 56). From intertidal sand, Atlantic Beach, North Carolina. Digests agar

Vibrio perimastrix Alarie. (Alarie, Thesis, MacDonald Coll McGill Univ, 1945, see Perlin and Michaelis, Sci., 105, 1946, 673) Will decompose cellulose only in presence of COr

l'abrio phytoplankits ZoBell and Upham. (Bull. Scripps Inst of Oceanography, Univ. Calif., 5, 1914, 261.) From sea water and marine phytoplankton.

Vibrio pieris Paillot. (Compt. rend. Soc. Biol., Paris, 94, 1926, 68.) From caterpillars of the cabbage butterfly (Pieris brassicae) which had been parasitured by larvae of Apanteles elomeratus.

Vibrio ponticus ZoBell and Upham. (Bull Scripps Inst. of Oceanography, Univ. Calif, 5, 1944, 259) From sea water.

Vibrio rumpel Lode (Cent. 1. Bakt., I Abt., Orig., 55, 1903, 526; see Ballner, Cent. f Bakt., II Abt., 19, 1907, 572.) From water. Phosoborescent.

From water. Phosphorescent.

Vibrio stanier: Humm (loc. cit, 57).

From seaweed (Acanthophora spicifera).

Miami, Fla. Digests agar.

Vibrio turbidus Humm (loc. cit., 57).

From seaweed (Gracilaria confervoides)

Digests agar.

Vibrio viridans Miller. (Quoted from Miller, Microorganisms of Human Month, Phila., 1890, 85, see Miller, Die Mikroorganismen der Mundhöhle, Lelpzig, 1893.) From the mouth

Xanthomonas transluess var. phleipratensis Wellin and Reddy. (Phytopathology, 35, 1945, 939) The causa of a bacterial streak disease on timothy grass (Phleum pratense)

Xanthemenas vignicola Burkholder (Phytopath, 54, 1944, 431.) From cowpea, Vigna sinensis.

Yersima van Loghem (Ann. Past. Inst., 72, 1946, 975), a genus proposed to include Pasteurella pestis and P. pseudotuberculosis

Ein neuer fur Thiere path, Mikroorg, aus dem Sputum eines Pneumoniekanken, Bunrel and Federin, Arch. I. Ilyg. 19, 1893, 326, Bacillus dubius pneumoniae
Kruse, in Flüger, Die Mikroorganismen,
3 Aufl. 2, 1896, 419; Bacterium zubpneumonicum Migula, Syst. d. Bakt. 2, 1900, 376; Bacterium dubium Chester,
Man. Determ. Bact., 1901, 142. From
the sputum of a pneumonia patient.

# FAMILY XIII. BACILLACEAE FISCHER.\*

(Jahrb. f. wiss. Bot., 27, 1895, 139.)

Rod-shaped cells, capable of producing spores, either with peritricbous flagella of non-motile, uncortrichous flagellation has been reported but is doubtful. Endospore are cylindrical, ellipsoidal or spherical, and are located in the center of the cell, sub-terminally or terminally. Sporangia do not differ from the vegetative cells except when bulged by spores larger than the cell diameter. Such sporangia are spindle shaped when spores are central, or wedge- or drumstick-shaped when spores are terminal. Usually Gram-positive. Figment formation is rare. Aerobic, microaco-philic or anaerobic. Gelatin is frequeotly liquefied. Sugars are generally fermently, sometimes with the formation of visible gas. Some species are thermophilic, i.e., will grow readily at 55°C. Mostly saprophytes, commonly found in soil. A few are animal, especially insect, parasites or pathocens.

### Key to the genera of family Bacillaceae.

I. Aerobic; catalase positive.

Genus I. Bacillus, p. 705.

II. Anaerobic or microaerophilic; catalase not known to be produced.

Genus II. Clostridium, p. 763

#### INTRODUCTION TO THE GENUS BACILLUS.

In the fifth edition of the Manual, the late F. D. Chester stated: "It is difficult to offer a rational system of classification for the described forms of the ganus Bacillus because of the incompleteness of the data". He prepared a splendid review of the literature but naturally could not supply the data that were missing. He stated further that "The majority of these scalled species in the genus have been imperietly presented,... the not result being that there are comparatively few clearly and definitely described species among the many herein recorded. The development of a better knowledge will be a work of the future". He then discussed the type of nork that should be done. A reading of his statement is recommended to anyone contemplating naming a new species.

During the past few years, the writer with the assistance of Francis E Clark and Ruth E. Gordon has made a study of the genus Bacultus along the lines indicated by Chester. Representative cultures have been obtained from various laboratories, institutions, and private collections Special mention should be made of the private collection of Prof. J. R. Porter, now at the lowa State University. It contained about 200 named species and was iovaluable for the work. As a result of this study, it appears that many species have been differentiated by such simple characters as mucoid, tolded, adherent or rhizond growth, pigment production, the fermentation of a specific carbobydrate set. Others have been grouped because of some special physiological

Species have been characterized upon a whole assumption that one species should not dissociate into another species. Since certain characters are more stable than others, these have been used to establish a

<sup>\*</sup> Revised by Mr. Nathao R. Smith, U. S. Bureau of Plant Industry Station, Beltsville, Maryland (Bacillus), August, 1913, and Prof. R. S. Spray, School of Medicine, West Virginia University, Morgantown, West Virginia (Clostridium), May, 1942.

species pattern. This has reduced the number of species of the mesophilic members of the genus from many poorly defined organisms to a few well characterized and delimited species. Intermediates occur between related species and have been treated as such. The report on which this arrangement is based has recently been published by Smith, Gordon and Clark (U. S. Dept. Agr. Mise. Pub. No. 559, 1916, 112 pp.).

Some workers may think that the cut in the number of species has been too drastic and that certain organisms listed as varieties, morphotypes, or botypes should be retained as species. This would not be consistent with the newer knowledge of bacteriology that has heen developed during the past two decades. No doubt other species occur in nature that are not included berein. But before jumping to the conclusion that a culture is a new species, closely related organisms as well as the isolate should be studied along the lines given by Chester in the fifth edition of the Manual.

The production of indole and the formation of H<sub>3</sub>S have been omitted from the descriptions because these characters have no taxonomic value. Certain other properties, such as colony form, character of the growth on slants, in litmus milk, etc., have a very limited value. They are included for the sake of completeness

### Genus I. Bacillus Cohn \*

(Beitrage z Biol. d. Pflanzen, 1, Heft 2, 1872, 146 and 175) From Latin bacillum, a small stick.

Synonyms. ? Bactrella Morren, Bull d Sci natur et de Geol , No 27, 1830, 203; ? Metallacter Perty, Zur Kenntniss kleinster Lebensformen, 1852, 180; ? Bacteridium Davaine, Diet. Encyclop, d Sei Méd , Ser I, 8, 1863, 21; Pollendera Trevisan, 1884 (see DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 043): Zopfiella Trevisan, Attı della Accademia Fisio-Medico-Statistics in Milano, Scr. 4, 3, 1885, 03; Cornilia Trevisan, I generi e le specie delle Batteriacee, 1889, 21; Urobacillus Miquel, Ann Microg , 1, 1889, 517, Bactersum Migula, Arb. bakt Inst Karlsruhe, 1, 1894, 237 (not Bacterium Ehrenberg, Symbolae Physicse seu Icones et Descriptiones Animalium, etc., Berlin, 1828, 8); Bactrinum, Bactridium, Bactrillium, Clostrillium, Clostrinium and Paracloster Fischer, Jahresb. f wissensch Bot , 27, 1895, 139; Endohacterium Lehmann and Neumann, Bakt, Ding , 1 Auff , 2, 1896, 103, Astasia Meyer, Flora, 84, 1897, 185; Saccharobacler Beijerinck, Cent f Bakt , II Abt , 6, 1900, 200; Fenobacter Beijerinck, ibid : Aplanobacter E F Smith, Bact. in Relation to Plant Dis , 1, 1905, 171, Semiclostridium Maassen, Arb. a d k Gesundheitsamte, Biol. Abt , 5, 1905, 5; Myzobacillus Gonnermann, Ztschr. f. Zuckerind. u Landwirtsch., 36, 1907, 877; Plennobacterium Gonnermann, abid ; Serratia Vuillemin, Ann. Mycolog., 11. 1913, 521 (not Serratia Bizio, Polenta porporina, Biblio Ital., 30, 1823, 288); Schaudinnum, Theciobactrum, Zygostasis, Eisenbergia, Migulanumand Rhagadascia Enderlein, Sitzber, Gesell, Naturf Freunde, Berlin, 1917, 309; Cellulobacillus Simola, Ann Ac. Sc Fenn , Ser. A, \$4, No 1 and 6, 1931 (abst in Cent f. Bakt , II Abt., 89, 1932, 89), not Cellulobacillus Orla-Jensen, Cent. f. Bakt., II Abt , 22, 1909, 343; Zumobacillus Kluyver and Van Niel, Cent f. Bakt., H Abt , 94, 1936, 369.

Rod-shaped bacteria, sometimes in chains Sporangia usually not different from the vegetative cells Catalase present. Aerobic, sometimes showing rough colonies and

Revised by Mr. Nathan R. Smith, U. S. Bur. Plant Industry Station, Beltsville, Maryland, August, 1943.

- b. Growth below 50°C.
  - c. Nitrites from nitrates, often with liberation of nitrogen gas.
    - · 21. Bacillus kaustophilus.
    - 21a. Bacillus pepo.
  - ce. No nitrites from nitrates.
- 22. Bacillus thermoindifferens. bb. No growth below 50°C.
- 23. Bacillus thermodiastaticus.
  2. Diameter of rods greater than 0.8 micron.
- a. Growth on nutrient agar.
  - b. Remnants of sporangium otherent.
  - 21. Bocillus cylindricus.
  - bb. Remnants of sporangium not adherent, 25. Bacillus robustus,
    - 25a. Bacillus losanitchii
- aa. No growth on nutrient ager.
- 26. Bacillus calidolactis.
- B Spores ellipsoidal to cylindrical, central to terminal; sporangia distinctly bulged.
  - 1. Diameter of rods less than 0.9 micron.
    - a Starch hydrolyzed.
      - b. Nitrites from nitrates, sometimes with liberation of nitrogen gas.
        - 27. Bacillus michaelisii.
        - 27a. Bacillus lobatus.
      - 27b. Bacillus thermononliquefaciens.
        - e Action on cellulose not recorded.
          - 23. Bacillus thermotranslucens.
            - 28a. Bacillus stearothermophilus.
        - 28b. Bacillus aerothermophilus.
        - cc. Cellulose hydrolyzed.
    - 29. Bacillus thermoeellulolyticus.
      - b. Nitrites from nitrates, sometimes with gaseous nitrogen.
        - c. Milk unchanged.
          30. Bacillus thermoalimentophilus.
        - cc Milk acid, coagulated.
      - 31, Bacillus thermoliquefaciens.
  - 2 Diameter of rods greater than 0 9 micron.
    - a Starch hydrolyzed
      - b No nitrites from nitrates
        - 32. Bacillus tostus.
- C Spores spherical, central to terminal; sporangium not distinctly bulged.

  33. Bacillus viridulus.
- 1. Bacillus subtilis Cohn emend Prazmowski (Cohn, Beitr. z Biol. d. Pflanzen, f. Heft 2, 1872, 174; Heft 3, 1875, 188; 2, Heft 2, 1876, 249; Prazmowski, Untersuchungen uber die Entwicklungsge-

schichte und Fermentwirkung einigen Bakterien-Arten, Inaug Diss., Leipzig, 1880) From Latin subfilis, thin, slender.

The identity of this species has been

the subject of some controversy owing to the indefiniteness of the original descriptions, to the distribution of cultures under the name Bacillus subtilis that were incorrectly identified, to variations in the forms of growth that may be observed, and to confusion with Bacillus cereus In cases where Bacillus subtilis is said to be "anthrax-like," or "similar to the anthrax bacillus," it should be remembered that these terms apply to Bacillus cereus and not to Bacillus subtilis Conn (Jour. Inf. Dis. 46, 1930, 341) concluded that the so-called Marburg strain fitted the earliest recognizable description of this species which is that given by Prazmonski (loc. cit.), and bis view was accepted after a study of cultures by the International Committee on Bacteriological Nomenclature (Jour. Bact . 33, 1937, 445)

During the past two decades much progress has been made in the study of variations in the stages of growth of baeteria, the rough, smooth, mucoid, etc., and in the variability in physiology as well From the recent work of Smith, Gordon, and Clark (loc cil ) it appears that many species have been characterized on such simple grounds as growth folded, mucoid, adherent, colored, shizoid, etc. all of which are subject to variation, either induced or spontaneous The present arrangement of this species is the result of their work combined with data supplied by the work of Conn and others

Species probably identical with or variants of Bacillus subtiles:

Bacillus geniculatus de Bary, Beitrag zur Kenntnis der niederen Organismen ım Mageninhalt, Inaug. Diss , Strassburg, Leipzig, 1885, Bacillus mesentericus fuscus Flugge, Die Mikroorganismen. 2 Aufl., 1886, 321 (Bacillus mesentericus Trevisan, I generi e le specie delle Batteriacee, 1889, 19, not Bacillus mesentericus as interpreted by Chester, Del. Agr. Exp Station 15th Ann. Report, 1903, 86; not Bacillus mesentericus as given by Lawrence and Ford, Jour Bact . 1, 1916. 295);\* Bacillus mesentericus vulgatus Flugge, Die Mikroorganismen, 2 Aufl., 1886. 322 (Bacillus vulgatus Trevisan, I generi e le specie delle Batteriacee, 1889. 19). Bacellus lindermos Flugge. Die Mikroorganismen, 2 Aufl., 1886, 323 (Baeillus No. X, Flugge, Ztschr. f Hyg , 17, 1894, 296; Bacillus lactis No. X. Kruso. in Flugge, Die Mikroorganismen, 3 Aufl , 2, 1896, 209; Bacillus intermedius Migula, Syst d. Bakt., 2, 1900, 579; Bacillus cremoris Chester, Man Determ Bact., 1901, 274). Bacillus lacus Frankland and Frankland, Philos Trans Roy, Soc. London, 178, B, 1887, 278 (not Bacillus laevis Distaso, Cent f. Bakt., I Abt., Orig , 62, 1912, 444); Tyrothriz tenuis Duclaux, Ann Inst Nat. Agron . 4. 1882. 23 (Bacillus tenuis Trevisan, I genera e le specie delle Batteriacee, 1889. 16); Kartoffelbacillus, Globig, Ztschr. f Hyg., 5, 1888, 294 (Bacillus roscus Trevisan, loc. cit . 19, Bacillus mesen-

tersous ruber Kruse, in Flugge, Die

<sup>\*</sup>T. Gilson, University of Edinburgh (personal communication), has found that the European and supposedly the original strained Bacillas mentaricus hydrolyze starell and reduce nitrates to nitrites, whereas the American strains are negative in both of these characters. Furthermore, he fatter are usually smooth and when the rough stage exists, it does not resemble a mescalery from which the organism derived its name. This term, however, can still be applied to the European strains. Since the American strains are identical with Bacillas punulus (Chester, Del. Agr. Evp. Station, 18th Ann Report, 1903, 87; Lawrence and Ford, Jour Bact. 1, 1916, 300), it has been recommended (Smith, Gordon, and Clark, bee at 1) that they be designated as Bacillus punulus to avoid ambiguity. Since the European Bacillus metantericus is only a stage of growth of Bacillus withst, the former name should be dropped.

Mikroorganismen, 2, 1896, 199; Bacillus globigii Migula, Syst. der Bakt., 2, 1900, 554; Bacillus vitalis Chester, Man. Determ. Bact., 1901, 286); Bacillus leptosporus Klein, Cent. f. Bakt., 6, 1889, 316; Bacillus No. 6, Pansini, Arch. f. nath. Anat. u. Physiol., 122, 1890, 422 (Bacıllus coccoideus Migula, Syst. der Bakt., 2, 1900, 558); Bacillus radians Migula, Syst. d. Bakt., 2, 1900, 580 (Bacillus No. IX, Flugge, Ztschr. f. Hyg , 17, 1894, 296; Bacillus lactis No. IX, Kruse, in Flugge, Die Mikroorgenismen, 3 Aufl., 2, 1896, 209; Bacillus stellatus Chester, Man. Determ, Bact., 1901, 274; not Bacillus stellatus Vincent, Ann. Inst. Past., 21, 1907, 69); Bacillus mesentericus panis viscosi II Vogel, Ztschr. f. Hyg., 26, 1897, 401 (Bacillus panes Migula, \*\* Syst der Bakt., 2, 1900, 576); Bacillus armoraciae Burchard, Arb. a. d. bakt. Inst. d. techn. Hochschule zu Karlsruhe, 2, 1898, 46; Bacillus idosus Burchard, sbid., 47; Bacillus subtilis a Gottheil, Cent. f. Bakt., II Abt., 7, 1901, 635, Bacillus natto Sawamura, Bull Coll Agr., Tokyo, 7, 1906, 108; Bacillus mesentericus var. flagus Laubach, Jour. Bact., 1, 1916, 497 (Bacillus flavus Bergey et al , Manual, 1st ed., 1923, 286, not Bacillus flavus Fuhrmann, Cent f Bakt., II Abt., 19, 1907, 117); Bacillus truffauti Truffaut and Bezssonoff, Compt rend Acad Sci., Paris, 175, 1922, 544; Bacillus mesentericus hydrolyticus Hermann and Neuschul, Biochem. Ztschr , 281, 1935, 219.

The name Vibrio subtilis Ehrenberg (Infusionsthierchen als vollkommene Organismen, Leipzig, 1838) seems to have given rise to the species name.

Spores: 0.6 to 0.9 by 1.0 to 1.5 microns, ellipsoidal to cylindrical, central or paracentral. Germination prevailingly equatorial.

Sporangia: Ovoid to cylindrical, only slightly bulged if at all.

Rods: 0.7 to 0.8 by 2.0 to 30 microns, single or in short chains, rounded ends, uniformly. Motile. Gram-positive. The following variations have been observed: Smaller or larger rods, filaments, encapsulated cells (the slimy bread organisms), few shadow forms, nonmotile and Gram-variable. Rods on glucoso nutrient agar store small amount of fat.

Gelatin stab : Liquelaction.

Agar colonies: Usually rough, finely wrinkled, opaque, dull, adherent, slightly spreading, brownish tinge. Variations may be smooth, soft, thin, translucent, non-adherent, dendroid, coarsely wrinkled, creamy-white to yellowish to orange.

Agar slants. Growth abundant, flat, spreading, usually has a dull mat surface, finely wrinkled, adherent, becoming slightly brownish. Variations may be coarsely wrinkled or folded, non-adherent, smooth, thin, translucent, dendroid, creamy-white to yellow to orange. Some strains show a greenish fluorescence when grown at 45°C on nutrient agar.

Broth Turbid becoming clear with formation of a tough, wrinkled pellicle. Milk. Slowly peptonized, becoming

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alkaline.

<sup>\*\*</sup> There has been confusion about the identity of the so-called slimy bread bacteria. Lehmann and Neumann (Bakt. Ding , 7 Aufl , 2, 1927, 616) stated that they 'stranslated and also more or less closely related to Bacillus mesentericus and

From this and the work of Smith, conton and the slamy bread organisms are mucoid variants of Equillus subtilis, which may or may not be encapsulated, and motile or non-motile (see also Bacillus subtilis var. viscosus Chester, Del. Agr. Exp. Station, 15th Ann. Report, 1903, 84).

Milk agar plate: Casein hydrolyzed Potato: Growth luxuriant, warty or wrinkled to coarsely folded, whitish to pink or yellow, becoming brownish with age.

Nitrites formed from nitrates

Starch is bydrolyzed.

Acid with ammoniacal nitrogen from xylose, arabinose, glucose, fructose, galactose, mannose, maitose, sucrose, salicen, glycerol, and mannitol. Usually acid from dettrin. Variable reactions on rhamnose, raffinose, and inulin Usually no action on lactose

Acetylmethycarbinol produced

Catrates utilized

Optimum temperature 30° to 37°C Will usually grow from 50° to 56°C

Aerobie, facultative.

Source: Original cultures isolated by Cobn from an infusion of lentils (1872), from a boiled infusion of cheese and white bets (1875), and from boiled hay infusions (1876). Hence, frequently called the hay becilius The folded, non-adberent stage of growth (Bacillus rulgatus and the European strain of Bacillus mesenticius) is often called the potato bacillus Manner of germanation of spores established by Prazmowski (loc citi.).

Habitat: Widely distributed in soil and in decomposing of zanic matter

Nors: Beaillus sulfatus has long been separated from Beatlly subtiles by the folded character and tip non adherence of its growth Recently Lamanna (four Bact, 44, 1912, 611) has attempted to separate this species from Beatllus subtilis by the splitting of the spore sheath along the transverse axis upon germmation. Since the two species are otherwise morphologically and physiologically albe and since these characters are subject to valid

, if he

growth; for instance, Bacillus subtilis morphotype vulgatus (or mesentericus) for the folded growth, Bacillus subtilus morphotype panis for the slimy growth, and Bacillus subtiss morphotype globigii for those that produce a red or orange pigment. These terms would apply to the present condition of the culture and would have to be changed if the character of the growth changed.

In Bacillus subhits var. aterrimus comb now (Potato bacillus, Biel, Cent. f., Bakt., II Abt., \$2, 1896, 137; Bacillus aterrimus Lelimann and Neumann, Bakt., Diag., I Aull., \$2, 1896, 303; Bacillus mecanieraus niger Lunt, Cent., I Bakt., II Abt., \$2, 1896, 572; Bacillus niger Chester, Man Determ. Bact., 1901, 306.) From Latin aterrimus, very black.

Syronyms. Basilius nigrificans Fabian, and Nienburs, Micb. Agrie. Exp. Station, Tech. Bull. 140, 1934, 24; Basilius (grosimogenes Ruscon, as referred to by Carbone et al., Instit. Sierot. Milan. 4, 1921-1922, 29; not Basilius grosimogenes Illall and Finnerud, Proc. Soc. Expl. Bull and Med. 18, 1921, 48 and Hall, Abstr. Bact. 5, 1922, 6.

In the carly accounts the production of a blue black to black pigment on potato of a blue black to black pigment on potato was stressed. It was also said to resemble Bacillus subtitus and Bacillus subgetus on gelatin plates. Recent work (Clark and Smith, Jour Bact, \$7, 1939, 280) has shown that pigmentation occurs only in the presence of a carbohydrate. In addition (Cordon and Smith, Jour Bact., \$4, 1942, 53), it was established that the ability to form the pigment could be lost through serial transfers and colony selection and that the resultant dissociants could not be differentiated from Reallilus subtilis.

Source Isolated from rye bread in moist chamber used for growing some aspergilli (Biel).

Habitat. Widely distributed in soil.

1b Bacillus subtilis var niger comb. nov. (Bacillus lactis niger Gorini, Gior. d. Reale Soc. Ital. Ig , 18, 1894, 9; Bacillus niger Migula, Syst. der Bakt., 2, 1900, 636.) From Latin niger, black.

The black pigment characterizing this organism is formed only in media containing tyrosine (Clark and Smith, Jour. Bact., 87, 1939, 279). The ability to form the pigment may be lost through serial transfer and colony selection. It then cannot be separated from Bacillus wibtlis (Gordon and Smith, loc. cit.).

Source. First isolated from milk. Habitat: Widely distributed in soil

2. Bacillus pumilus Gottheil. (Cent. f. Bakt., II Abt , 7, 1901, 681.) From Latin pumilus, dwarfish, little.

Synonyms: Bacillus mesentericus as interpreted by Chester, Del. Agrie. Exp. Station, 15th Ann. Report, 1903, 87; Bacillus mesentericus as given by Lawrence and Ford, Jour. Bact., I, 1916, 205 and 300; Bacillus mesentericus var. flavus Laubach, Jour Bact., I, 1916, 407; perhaps also Bacillus parvus Neide, Cent. It. Bakt., II Abt., 12, 1904, 341; Bacillus leptodermis Burchard, Arb a d bakt. Inst. d. techn Hochschule zu Karlsruhe, 2, 1998, 33

Spores: Ellipsoidal to cylindrical, thin walled, naked, central or paracentral, usually about 0.5 by 1.0 micron although some may approach the size of those of Bacillus subtitis

Sporangia · Ellipsoidal to cylindrical, not bulged.

Rods · 0 6 to 0 7 by 2 0 to 3.0 microns, usually occurring singly or in pairs. Chains, filaments and shadow forms may be found in some strains. Cells grown on glucose nutrient agar have few small fat globules. Motile with peritrichous flagella Gram-positive.

Gelatin stab Slow liquefaction.

Agar colonies. Thin, flat, spreading, dendroid, smooth, translucent. The rough stage also occurs

Agar slants Growth moderate, smooth, soft, thin, glistening, non-adherent, spreading, usually whitish although it may be yellowish. The rough stage is tough and finely wrinkled, sometimes resembling certain strains of Bacillus subtilis.

Broth: Uniform turbidity, with or without a ring or half-formed pellicle. The rough stage forms a pellicle.

Milk: Peptonized, sometimes coagulated.

Milk agar plate Casein hydrolyzed. Potato: Growth is smooth, thin, spreading, moist to slimy, yellowish, turning

ing, moist to slimy, yellowish, turning somewhat brown. The rough stage is dry and finely wrinkled.

Nitrites not produced from nitrates. Starch not hydrolyzed.

Acid with ammoniacal nitrogen from arabinose, xylose, glucose, fructose, galactose, mannose, sucrose, salicin, glycend and mannitol; usually also from malues and raffinose. Reaction variable with dextrin. Usually no acid from rhamnose, lactose, and inulin.

Acetylmethylcarbinol produced.

Citrates utilized as sole source of carbon.

Optimum temperature about 30°C. Maximum temperature allowing growth usually about 50°C.

Acrobic. Source: Isolated from plants, cheese, dust, and as a contaminant of media.

Habitat: Widely distributed in nature.

 Bacillus cos gulans Hammer. (Iowa Agric. Exp. Station, Research Bull. 19, 1915, 129; Sarles and Hammer, Jour-Bact., 23, 1932, 301.) From Latin coagulans, curding, coagulating.

Synonyms: Bactlus thermoacidurans Berry, Jour. Bact., 25, 1933, 72; Bacillus deztrolacticus Andersen and Werkman, Iowa State Coll. Jour. of Sci., 14, 1940, 187.

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Spores: Ellipsoidal to cylindrical, terminal or subterminal, thin walled, 06 to 09 by 1.0 to 1.5 microns. Sporulation better on acid proteose peptone agar (Stern, Hegarty, and Williams, Food Research, 7, 1942, 183).

Sporangia: Only slightly awollen, if at 411

Rods: 05 to 09 by 2.5 to 3 microns. singly or in short chains, resemble Bacillus subtilis. Cells from glucose agar contain few small fat globules Motile Cram-positive.

Celatin No growth at 20°C No change in gelatin by Frazier method at 45°C.

Agar colonies: Small, entire, raised, not characteristic.

Agar slants . Growth scant to moderate. thin, flat. On acid proteose pentone agar growth is more abundant and microscopically the cells appear healthier

Broth Moderate uniform turbidity. followed by clearing Glucose broth attains a pH of 40 to 44

Milk: Coagulated Milk agar plate, Weak hydrolysis of

casein Potato: Growth scant to moderate,

thin, spreading, white to cream-colored May have a sour odor.

Nitrites usually not formed from nitrates.

Starch is hydrolyzed Acid from glucose, galactose, fructose,

lactose, maltose, sucrose, devtrin, and glycerol. Usually no acid from arabinose and sorbitol No acid from xylose and mannitol Organic nitrogen preferable to morganic

Acetylmethylcarbinol produced.

Citrates not used as sole source of carbon

Optimum temperature about 45°C (Hammer, 55°C). Maximum temperature allowing growth 54°C to 60°C Slow growth, if any, at 25°C

Aerobic, facultative

Source Isolated from evaporated mulk (Hammer) and tomato juice (Berry). Habitat Canned goods; probably

widely distributed in nature.

4 Bacillus firmus Werner. (Cent f. Bakt , II Abt , 87, 1932, 470 ) From Latin firmus, firm, stmng

Spores: Usually ellipsoidal, central to subterminal, 06 to 0.7 by 10 to 12 microns on Ca-n-butyrate agar (Werner): 07 to 09 by 10 to 1.4 microns on nutrient agar. Sporulation better on plain peptone agar than on nutrient agar. Sporangia: Ellipsoidal to cylindrical.

sometimes slightly bulged

Rods . 0 6 to 0 9 by 1 5 to 4.0 microns, single or in abort chains, few filaments On glucose nutrient agar there are swollen, shadow, and other abnormal forms. few amall fat globules. Motile with peritrichous flagella Gram-positive

Gelatin stab : Slow liquefaction, Gelatin plate shows wide zone of hydrolysis. Agar colonies: Small, smooth, dense,

entire, white to pink.

Agar slants Growth moderate, smooth, opaque, not spreading, whitish, Pink variations may occur. Growth inhibited when glucose is added, because of the production of send No growth at pH 60 or below. Broth Scant uniform turbidity or a

flocculent growth. Milk agar plate: Weak to strong essein

hydrolyais.

Potato: No growth. Nitrites produced from nitrates

Starch is hydrolyzed

Acid from glucose No neid from arabinose and vylose Ammonium salts not used as sole source of nitrogen.

Acetylmethylcarbinol not produced. Citrates usually not utilized

Urease not produced

Salt tolerance Will grow in nutrient broth containing 4 to 7 per cent NaCl Optimum temperature about 28°C.

Maximum temperature allowing growth 37°C to 45°C. Source. Seven strains isolated from

soils at Central Europe and Egypt. Habitat · Widely distributed in soil.

5. Bacillus lentus Cibson, (Cent. f. Bakt , H Abt., 92, 1935, 368 ) From Latin lentus, slow.

Spores: Ellipsoidal, central to subterminal, 0.7 to 0.8 by 1.0 to 1.3 microns

Sporangia: Ellipsoidal to cylindrical, may be slightly swollen.

Rods: 06 to 0.7 by 2.0 to 3.0 microns. occurring singly or in pairs. Motile with peritrichous flagella. Cram-positive.

Gelatin stab: No liquefaction, No change in gelatin by Frazier method.

Agar colonies: Small, smooth, entire.

glistening, white, opaque. Agar slants: Crowth only moderate, slow, thin, gray to white, opaque, not spreading. No growth at pH 6.0 or below. Crowth inhibited by glucose because of

the change to acid reaction. Broth Faint uniform turbidity, granu-

lar sediment.

Milk: Unchanged.

Milk agar plate: Casein not bydrolyzed.

Potato: No growth.

Nitrites not produced from nitrates. Starch is hydrolyzed.

Acid from arabinose, vylose, glucose, sucrose, and lactose. Inorganic nitrogen

not utilized Acetylmethylcarbinol not formed.

Citrates not used as sole source of

carbon. Urease produced. Urea decomposed at

room temperature, feebly at 37°C. Salt tolerance. Will grow in nutrient broth containing 4 per cent NaCl.

Optimum temperature about .25°C. Maximum temperature allowing growth

Growth on most media is increased by

tbe addition of urea

Aerobie.

Nine strains isolated from Source

Habitat · Common in soils.

Bacillus megatherium De Bary. (Bacıllus megaterium (sic) De Bary. Vergleichende Morph und Biol. der Pilze, 1884, 490 ) Generally assumed that the original spelling was a typographical error and that the later spelling megatherium comes from Creek roots meaning big animal (Breed, Science, 70, 1929, 480). Rippel (Arch. Mikrobiol., 11. 1940, 470) holds that the original spelling meaning big rod is the correct form.

Synonyms as given by Smith, Gordon, and Clark (loc. cit.): Bacillus capri Stapp, Cent. f. Bakt., II Abt., 51, 1920, 19: Bacillus carotarum Koch, Bot. Zeit., 18, 1888, 277 (Bacterium carotarum Migula, Syst. d. Bakt., 2, 1900, 293); Bacillus cobayac Stapp, Cent. f. Bakt , II Abt., 51, 1920, 10; Bacillus danicus Löhnis and Westermann, Cent. f. Bakt II Abt., 22, 1908, 253; Bacillus graveolens Gottheil, Cent. f. Bakt., H Abt., 7, 1901, 496 and 535; Bacillus malabarensis Löhnis and Pillai. Cent. f. Bakt. II Abt., 10, 1907, 91; Bacillus musculi Stapp, Cent f. Bakt., II Abt , 51, 1920, 39; Bacillus oxalaticus Migula, Arb a. d bakt. Inst d. Tech. Hochschule s. Karlsrnhe, 1, Heft, 1, 1894, 139; Bacillus petasites Gottheil, Ceat, f. Bakt, II Abt., 7, 1901, 535 (Lawrence and Ford, Jour. Bact , 1, 1916, 273); Bacellus ruminalus Cottheil, ibid , 496; Bacillus silvaticus Neide, Cent. f. Bakt., II Abt, 12, 1904, 32; Bacillus tumescens Zopi, Die Spaltpilze, I Aufl., 1883, 66 (Zopfiella tumescens Trevisaa, Car. d. ale. nuov gen, di Batter., 1885, 4).

Other possible synonyms given by Neide (loc. cit., 11): Bacterium hirlum Henrici, Arb. bakt. Inst. Karlsruhe, I, 1891, 44 (Pseudomonas hirtum Ellis, Cent f Bakt., II Abt., 11, 1903, 243; Bacillus hirtus Ellis, Ann. Bot., 20, 1906, 233); Bacillus brassicae Pommer, Mitt. botan Inst Graz, 1, 1886, 95 (Bacterium brassicac Migula, Syst. d Bakt., 2, 1900, 296).

Although the name Bacillus tumescens Zopf (which is here regarded as a probable synonym) has priority over Bacillus megatherium, the latter name is preferred because of general usage Neither of the original descriptions is sufficiently detailed to characterize adequately the

species named, and Zopf (Die Spaltpilke, 3 Anfl., 1885, 82-83) regarded the two species as distinct. The modern work on which the present description of Bacillus megatherium is based has been largely carried out with cultures identified as Bacillus megatherium, and the true nature of the species is really fixed by the informal emendations made in these more recent descriptions. The emended descriptions give this name a more certain meaning than is given Bacillus lumescens by the descriptions existent in the literature.

Spores: Ellipsoldal, sometimes nearly round, tentral to paracentral, 10 to 15 by 15 to 20 microns (larger dimensions have been reported)

Sporangia. Ellipsoidal to cylindrical, often in short chains; not avollen

Rods: 12 to 1.5 by 20 to 40 merons, occurring singly and in short chains Larger and smaller cells, irregular, twisted, and shadow forms are present in some strains, depending upon the substrate Gells from glucoso or glycerol nutrient agar usually store much fat and stain unevenly (vacuolated) with dilute stains. Motility with perturchous flagella, usually slow, although some strains may show active motility. Gram-positive.

Gelatin stab . Slow liquefaction

Agar colonics Large, smooth, soft, convex, entire, opaque, creamy-white to yellow The rough stage is usually concentrically ridged with a thin edge

Agar slants Growth abundant, soft, butyrous, creamy-white to yellow with pellicid dots. Browning with age, a few strains become black if the medium contains tyrosine.

Broth. Medium to heavy uniform turbidity.

Milk . Peptonized

Milk agar plate Cascin hydrolyzed

Potato: Grow th shundant, smooth, soft to slimy, spreading, creamy-white, pale to lemon-yellow or pink A few strains are orange-colored, some blacken the potato. The rough stage is wrinkled.

Nitrites usually not produced from

Starch is hydrolyzed.

Acid with ammoniacal nitrogen from arabinose, glucose, fructose, sucrose, maltose, destrin, inulin, salicin, glycerol and mannitol Usually scid from vylose, galactose, mannose, and raffinose; variable from lactose Generally no acid from rhamnose.

Acetylmethylcarbinol not formed. Citrates used as sole source of carbon,

Une acid bydrolysis: Variable Optimum temperature 28°C to 35°C. Maximum temperature allowing growth usually between 40°C and 45°G.

Source Originally isolated from cooked cabbage

Habitat. Widely distributed in soil, water, and decomposing materials.

Note: A description of Bacillus megathersum—Bacillus cereus intermediates follows the description of Bacillus cereus

7 Bacillus cereus Frankland and Frankland (Philosoph Transact. Roy. See London, 178, B, 1887, 279.) From Latin cereus, wayy

Synonyms. Bacillus ellenbachens: alpho Stutzer and Hartleb, Cent. f. Bakt, II Abt. 4, 1898, 31; Bacillus ellenbacheners Gotthell, Cent. f. Bakt, II Abt., 7, 1901, 540, Bacterum petroselini Burchard, Arb bakt frast Karlsruhe, 2, 1898, 39 (Bacillus petroselini Ichmann and Neumann, Bakt. Diag, 4 Aufl., 2, 1907, 411)

The following are given as possible syconyms by Gotthiell, Cent f. Bakt, II Abt. 7, 1901, 510 Bacillus ramosus liquefactens Flügge, Die Mikroorganismen, 2 Auf., 1586, 342; Bacillus stoloniferus Pohl, Cent. f Bakt., II, 1822, 342 (Bacterium stoloniferus Chester, Ann. Rept Del Col Agr. Evp. Sta. 9, 1837, 91; Achromobacter stoloniferum Bergey et al., Manual, 1st ed., 1923, 136); Bacillus limesus Russell, Zischr. f. llyg., II,

Spores: Ellipsoidal, central to subterminal, 0.7 to 0.8 by 1.0 to 1.3 microns.

Sporangia: Ellipsoidal to eylindrical, may be slightly swollen.

Rods: 06 to 07 by 2.0 to 3.0 microns, occurring singly or in pairs. Motile with peritrichous flagella. Gram-positive.

Gelatin stab: No liquefaction. No change in gelatin by Frazier method.

Agar colonies: Small, smooth, entire, glistening, white, opaque.

Agar slants: Growth only moderate, slow, thin, gray to white, opaque, not spreading. Nogrowth at pH 6 Oor below. Growth inhibited by glucose because of the change to acid reaction.

Broth: Faint uniform turbidity, granular sediment.

Milk · Unchanged.

Milk agar plute: Casein not hydrolyzed

Potato. No growth. Nitrites not produced from nitrates.

Starch is hydrolyzed

Acid from arabinose, vylose, glucose, sucrose, and lactose Inorganic nitrogen not utilized.

Acetylmethylcarbinol not formed.

Citrates not used as sole source of carbon.

Urease produced. Urea decomposed at room temperature, feebly at 37°C

Salt tolerance · Will grow in nutrient broth containing 4 per cent NaCl.

Optimum temperature about .25°C. Maximum temperature allowing growth 37°C.

Growth on most media is increased by the addition of urea

Aerobic.

Source: Nine strains isolated from soils.

Habitat: Common in soils.

6. Bacillus megatherium De Bary. (Bacillus megaterium (sic) De Bary. Vergleichende Morph und Biol der Pilze, 1884, 499.) Generally assumed that the original spelling was a typographical error and that the later spelling

megatherium comes from Greek rots meaning big animal (Breed, Science, 70, 1929, 480). Rippel (Arch. Mikrobid, 11, 1940, 470) holds that the orignal spelling meaning big rod is the correct form.

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gen. at Batter., 1885, 4).
Other possible synonyms given by
Neide (loc. cit., 11): Bacterium hirlum
Henrei, Arb. bakt. Inst. Karlsrule, 1,
1891, 44 (Pseudomonas hirtum Ellis,
Gent f Bakt., II Abt., 11, 1903, 213,
Bacillus hiritus Ellis, Ann. Bot., 29, 1906,
233); Bacillus brassicae Pommer, Mit
botan. Inst. Graz, 1, 1886, 95 (Bacterium
brassicae Migula, Syst d Bakt., 2, 1906,
296)

Although the name Bacillus tunescent Zopf (which is here regarded as a probable synonym) has priority over Bacillus megatherium, the latter name is preferred because of general usage. Neither of the original descriptions is sufficiently detailed to characterize adequately the

species named, and Zopi (Die Spaltpilze, 3 Aufi, 1888, 82-83) regarded the two species as distinct. The modern work on which the present description of Bacillus megatherium is based has been largely carried out with cultures identified as Bacillus megatherium, and the true nature of the species is really fixed by the informal emendations made in these more recent descriptions. The emended descriptions give this name a more certain meaning than is given Bacillus tumescens by the descriptions existent in the Interature

Spores: Ellipsoidal, sometimes nearly round, central to paracentral, 10 to 15 by 15 to 20 microns (larger dimensions have been reported)

Sporangia · Ellipsoidal to cylindrical, often in short chains; not swollen.

Rods 1.2 to 1.5 by 20 to 40 microns, occurring singly and in short chains Largor and smaller cells, irregular, twisted, and shadow forms are present in some strains, depending upon the substrate. Cells from glucose or glycerol nutrient agar usually store much fat and stain unevenly (vacuolated) with dilute stains. Motility with perturbious flagella, usually slow, although some strains may show active motility. Gram-positive.

Gelatin stab Slow liquefaction.

Agar colonies Large, smooth, soft, convex, entire, opaque, creamy-white to yellow The rough stage is usually concentrically ridged with a thin edge

Agar slants. Growth abundant, soft, butyrous, creamy-white to yellow with pellucid dots Browning with age; a few strains become black if the medium contains tyrosine

Broth: Medium to heavy uniform turbidity.

Milk . Peptonized

Milk agar plate: Casem hydrolyzed Potato Growth abundant, smooth, soft to slimy, spreading, creamy-white, pale to lemon-yellow or pink A few strains are orange-colored, some blacken the potato. The rough stage is wrinkled. Nitrites usually not produced from

nitrates

Starch is bydrolyzed.

Aed with ammoniacal nitrogen from arabinose, glucose, fructose, sucrose, maltese, devtrin, inulin, salicin, glycerol and mannitol. Usually acid from xylose, galactose, nannose, and raffinose, variable from lactose Generally no acid from rhamnose

Acetylmethylcarbinol not formed. Citrates used as sole source of carbon.

Uric acid bydrolysis: Variable.

Ontimum temperature 28°C to 35°C.

Maximum temperature allowing growth usually between 40°C and 45°C.

Source Originally isolated from cooked cabbage.

Habitat Widely distributed in soil, water, and decomposing materials.

Note A description of Bacillus megathersum—Bacillus cereus intermediates follows the description of Bacillus cereus.

7 Bacillus cereus Frankland and Frankland. (Philosoph Transact. Roy. See London, 178, B, 1887, 279) From Latin cereus, waxy

Synonyms Bacillus ellenbacheniss alpha Stutzer and Hartleb, Cent. f. Bakt., II Abt., 4, 1898, 31; Bacillus ellenbachensis Gottheil, Cent. f. Bakt., II Abt., 7, 1904, 519; Bacirum periorelini Burchard, Arb bakt. Inst. Karlsrube, 2, 1898, 39 (Bacillus petroscinia Lehmann and Neumann, Bakt Ding, 4 Aufl., 2, 1907, 441)

The following are given as possible syonoyma by Gottheil, Cant. f. Bakt., II Abt. 7, 1901, 510 Barillus ramous luquefacens Hügge, Die Mikronganusmen, 2 Aufl., 1886, 812; Barillus stoloniferus Pohl, Cent. f Bakt., 11, 1822, 142 (Bacterium stoloniferus Chester, Ann. Rept. Del. Col. Agr. Evp. Sta. 9, 1837, 91; Arkromobacter stoloniferum Bergey et al., Manual, 1st ed., 1023, 130; Bactilus horous Pussell, Ziecht. f. Hyg., 14.

1892, 196 (not Bacillus limosus Klein, Ber. d. deutsch. bot. Gesellsch. 7, 1899, 65; Bacullus limophilus Migula, Syst. d. Bakt., 2, 1900, 550); Bacillus breis o Flugge, Ztschr. f. Hyg., 17, 1894, 291; Bacillus ulukentus Kern, Arh. bakt. 1884. Karlsruhe, 1, 1897, 402; Bacillus goniasporus Burchard, Arb. Hakt. Inst. Karlsruhe, 2, 1898, 14; Bacterium turgescens Burchard, ibid., 18; Bacillus lexcursor Burchard, ibid., 25; Bacillus lexcursor Burchard, ibid., 25; Bacillus lexcursor Burchard, ibid., 37.

The following are also listed as synonyms or biotypes of Bacillus cereus by Smith, Gordon and Clark: Bacillus sessilis Klein, Cent. f. Bakt., 6, 1889, 349 and 377 (Bacterium sessile Migula, Syst. d. Bakt., 2, 1900, 290); Bacillus albolactis Migula, thid, 577 (Bacıllus lactis albus Loeffler, Berlin, klin. Wchnschr., 1887, 630); Bacillus lacticola Neide, Cent. f. Bakt., II Aht., 12, 1904, 163 (Bacillus No. V, Flügge, Ztschr. f. Hyg , 17, 1894, 294; Bacillus lactis No. V, Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 208; Bacterium lacticola Migula, Syst. d. Bakt., 2, 1900, 305; Bacillus excurrens Migula, thid, 582; Bacillus cereus Chester, Man Determ. Bact., 17. . . . . Frantiani

337 (Bacıllus No I, Flügge, Ztschr. f. Hyg., 17, 1894, 294; Bacillus fluggei Chester, Manual Determ. Bact., 1901, 281); Bacillus rodur Neide, Cent. f. Bakt , II Abt., 12, 1904, 18; Bacillus thuringiensis Berliner, Zeit. f. angew. Entomol., 2, 1915, 29 (see also Mattes, Gesellschaft zur Beford. der Gesam. Naturw , 62, 1927, 381; Bacterium thuringiensis Chorine, Internat. Corn Borer Invest., 2, 1929, 50); Bacillus cereus var. fluorescens Laubach, Jour. Bact , 1, 1916, 508 (Bacillus fluorescens Bergey et al , Manual, 1st ed., 1923, 298; not Bacillus fluorescens Trevisan, I geners e le specie delle Batteriacee, 1889, 18), Bacellus subteles Michigan strain, Conn., Jour Inf. Dis , 46, 1930,

341; Bacillus undulatus den Dooren de Jong, Cent. f. Bakt., I Abt., Orig., 12; 1931, 277 (see also den Dooren de Jong, Arch. f. Alikrobiol, 4, 1933, 30); Bacillus siamensis Siribaed, Jour. Inf. Dis., 57, 1935, 143 (see also Bacillus cereus var. siamensis Clark, Jour. Bact., 33, 1937, 435); Bacillus meticus Chailton and Levine, Iowa Eng. Exp. Station, Bull. 132, 1937, 18; (see also Levine, Buchanan and Lease, Iowa State Coll. Jour. Sci., 1, 1927, 379); Bacillus tropleus Heaslip, Med. Jour. Australia, 28, 1941, 538.

Neide (loc. cit.) gave the following as possible synonyms of Bacillus lacticola. Bacillus butyricus Hueppe, Mitteil. a. d kaiserl. Gesundheitsamte, 2, 1884, 309; not Bacillus butyricus Mace, Traité de Bact., 1st ed., 1888 (Clostridium butyricum Prazmowski. Untersuchungen über die Entwickelungsgeschichte und Fermentwirkung einiger Bacterien-Arten Inaug. Diss., Leipzig, 1880, 23); Bacillus gureus Pansini, Arch. f. pathol. Anst. u. Physiol., 122, 1890, 436 (not Bacillus aureus Frankland and Frankland, Philos Trans. Roy. Soc. London, 178, B, 1887, 272); Bacillus lacteus Migula, Syst. u Bakt., 2, 1900, 571 (No. 17, Lemble, Arch f. Hyg., 29, 1897, 323); Bacillus goniosporus Burchard, loc. cit.

Neide also gave the following as possible synonyms of Bacillus lactis: Bacillus lutulentus Kern, loc. cit.; Bacillus or gomeratus Migula, Syst. der Bakt., 2, 1900, 557; Bacillus amerikans Mucha, sbid., 584; Bacillus acquindrosporus Burchard, Arb. bakt. Inst. Karlsruhe, 2, 1895, 31.

Other possible synonyms of Bacillus cereus are: Bacillus anthracoides Illoppe and Wood, Ber. klin. Wehnschr., 18, 1889, 347 (Kruse, in Flügge, Die Mikwarganismen, 3 Aufl., 2, 1896, 223 [enterium anthracoides Migula, Syst. der Bakt., 2, 1909, 281; not Bacterium archaeodes Trevisan, I generi e le specie delle Batteriance, 1889, 20); Bacillus pseudanthracis Wahrlich, Baktelis Studien, Petersburg, 1800-01, 26 (not

Bacillus pseudanthraeis Kruse, in Ffégge, Die Mikroorganismen, 3 Auft, 2, 1896, 233, Bacterium pseudoanthraeis Migula, loc. ett, 282); Bacterium fiele Burchard, Inaug. Dres., Karlsrühe, 1897 and Arh bakt Inst Karlsrühe, 1897 and Arh bakt Inst Karlsrühe, 2, 1893, 16; Bactlius et Burchard, 1809, 105, Bactlius koplositerius Paüllot, Compt rond. Acad. Sci. Paris, 162, 1916, 772; Bactlius koplinians Schirer and Greenfield, Trans. Roy. Soc. So Africa, 17, 1920, 309

Spores · Ellipsoidal, average size 1 0 by 1.5 microns (considerable variation has been noted by various writers), central or paracentral, usually freely formed in 24 hours Germination prevailingly polar

Sporangia: Ellipsoidal or cylindrical, only slightly swellen, if at all In short

to long chains.

Rods: 10 to 12 by 30 to 50 microns, occurring in long chains, ends square Cells appear granular or foamy if lightly stained, especially if grown on glucose or glyecrol nutrent agar; fat usually stored Smooth strains are motile with many peritrichous flagella, rough strains weakly motile or non-motile Gram-positive motile or non-motile Gram-positive

Gelatin stab: Rapid liquefaction

Agar colonies: Large, flat, entire or Irregular, whitish with characteristic appearance by transmitted light described by various observers as ground glass, morie silk, or galvanized iron All stages occur from the thin, spreading, very rough and arborescent, to the smooth dense form of colony

Agar slant Growth abundant, usually non-adherent, spreading, dense, whitsh to slightly yellowish. Old slants show characteristic whin-like outgrowths Some strains produce a yellowish-green fluorescence

Broth Heavy uniform turbidity, with or without a fragile pellicle

Milk. Rapid peptonization, with or without slight coagulation.

Blood scrum. Partially hquefied. Hemolysis on blood agar. Potato: Growth abundant, thick, soft, creamy-white to pinkish, spreading over the potato. Rough strains may be folded and more pigmented.

Nitrites usually produced from nitrates.

Starch is hydrolyzed.

Acid (with ammonacal nitrogen) from glucose, fructose, maltose, dextrin, and glycerol Acid usually from sucrose and salsein. Usually no acid from mannose and Lactose No acid from arabinose, thamnose, xylose, raffinose, inulin, and mannitol.

Acetylmethylcarbinol produced.
Citrates usually utilized as sole source

Optimum temperature about 30°C.

Maximum temperature allowing growth varies from 37°C to 48°C, usually about 43°C

Aerobic.

Source: From soil, dust, milk, plants, and as contaminant of media

Habitat, Widely distributed. Occurs more often in soil than any other member of the genus. See Chester, Del. Agr. Exp Station, 15th Ann. Report, 1903, 73; Lawrence and Ford, Jour. Bact., 1, 1016, 284; Conn. N. Y. Lvp Station, Tech. Bull. 58, 1917; Conn and Breed, Jour. Bact., 4, 1919, 273, Soriano, Thesis, Univ Buence Aires, 1935, Soriano,

Bacillus megatherium-Bacillus cereus intermediates

According to Smith, Gordon, and Clark (loc cit) intermediate forms occur between Bacultus wegatherum and Bacultus cereus which cannot be represented by a distinct species. These intermediates are characterized morphologically by the early appearance on agar of shadow or distorted forms, long filaments, and generally only a few spores. Fat globules are smaller and less numerous. Physiologically the group is erratie, showing a progression of characters from Bacultus megatherum on the one hand to Baciltus cereus on the other. Acetylmethylcarbi-

nol and nitrites are not usually formed. Fermentation of the pentoses and mannitol, the ability to grow well on glucose nitrate agar, susceptibility to the bacteriophage active against Bacillus megatherium or Bacillus cereus and the general character of the growth determines whether the intermediate is more closely related to Bacillus megatherium or to Bacillus cereus.

Bacillus cohaerens Gottheil (Cent. f. Bakt., II Abt., 7, 1901, 453 and 689) may be taken as a representative of this intermediate group resembling Bacillus megatherium more closely than Bacillus cereus. Gottheil gave as possible synonyms: Bacıllus vermicularis Frankland and Frankland, Ztschr. f. Hyg., 6, 1889. 384 (Bacterium vermiculare Migula, Syst. d. Bakt., £, 1900, 302); Bacillus filiformis Tils, Ztschr f. Hyg., 9, 1890, 203; Bacillus lactis albus Eisenberg, Bakt Diag., 3 Aufl., 1891, 110; Bacillus rirgalus Kern, Arb. bakt. Inst. Karlsruhe, 1, 1897, 416; Bacillus cylindrosporus Burchard, Arb. bakt. Inst Karlsruhe, 2, 1898, 31; Bocillus bipolaris Burchard, ibid . 34.

Other strains which apparently belong to this same group re: Bacterium pansinii Migula, Syst. d. Bakt, 2, 1900, 303 (Bacillus No. 3, Pansini, Arch. f. path. Anat, 128, 1800, 480; Bacterium granulatum Chester, Man. Determ. Bact., 1901, 180); Bacterium tomenlosum Henrici, Arb bakt Inst Karlsruhe, 1, 1807, 40; Bactllus teres Neide, Cent f. Bakt., II Abt., 12, 1904, 161.

Representing those strains in this intermediate group more closely related to Bacillus cerus is Bacillus simplez Gottheil (loc. cit., 685). Gottheil gave the following as possible synonyms: Bacillus vacuolosis Sternberg, Manual of Bac-1803, 717; Bacillus natans Kern, Arb. bakt Inst Karlsruhe, 1, 1891, 413; Bacillus loxosporus Burchard, Arb. bakt. Inst Karlsruhe, 2, 1893, 49

7a. Bacillus cereus var. mycoides (Flugge) comb. nov (Bacillus mycoides Flügge, Die Mikroorganismen, 2 Auß, 1886, 324.) From Greek mykes, fungus; eides, form, shape, i.e., fungus-like

Gottheil, Cent. f. Bakt., II Abt., 7. 1901, 589, gave the following as probable synonyms: Wurzelbaeillus, Eisenberg, Bakt. Diag., 1st ed., 1886, 4; Bacillus figurans Crookshank, Manual, 1st ed. 1886 (Bacterium figurans Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 134); Bacillus brassicac Pommer, Mitt a. d. botan. Inst. zu Graf, 1, 1886, 95 (Bacterium brassicae Migula, Syst. d. Bakt., 2, 1900, 296); Bacterium casci Migula, Syst. d. Bakt., 2, 1900, 304 (Bacillus No. XVI, Adametz, Landw. Jahrh., 18, 1899, 248; Bacterium proteum Chester, Man. Determ. Bact., 1901, 195); Bacillus ramosus Frankland and Frankland, Ztschr. f. Hyg., 0, 1889, 383 (not Bacillus ramosus Veillon and Zuber, Arch. Med. Exp. et Anat Path, 10, 1898, 542); Bacillus radicosus Zimmermann. Die Bakterien unserer Trink. v Nutznasser, etc., I Reihe, 1800, 30 (Bacterium radicosum Migula, Syst. d. Bakt., 2, 1900, 253); Bacillus implexus Zimmermann, ibid (Bacterium implexum Migula, ibid., 208); Bacillus intricatus Migula, sbid., 546 (Cladothrix intricata Russell, Ztschr. f. Hyg., 11, 1802, 191).

Another possible synonym is Bacillus pranssnitzii Trevisan (I generi ele specie delle Batteriace, 1859, 20). Laubach, Jaur. Bact., 1, 1916, 495, found that this differed from Bacillus mycoides only to the fermentation of lactose. This has

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variations of Bacillus mycoines smillus effusus, Bacillus olfactorius, Bacillus nanus and Bacillus dendroides (not Bacillus dendroides Thornton, Ann. Appl. Biol, 9, 1022, 247).

Bacillus cereus var mycoides is identi-

cal in all respects with Bacillus cereus except in the following characters:

Agar colonies. Grayish, thin, widely spreading by means of long twisted chains of cells, turning to the right or left.

Agar slants Growth thin, rhizoid, grayish, widely spreading, adhering to or growing into the agar. Later, growth becomes thicker and softer.

The physiological similarity between Bacillus cerves and Bacillus mycodes has often been noted. Gordon (Jour Bact, 39, 1910, 98) showed that the Thizoud character of the growth of Bactlus mycodes was readily lost by cultivation in flasks containing 100 ml of borth and that the resulting dissociants could not be differentiated from Bacillus cerus. It is, therefore, a question whether Bacillus mycoides should be given the dignity of a variety of Bacillus ecreus or merely designated as a stage of growth (morphotype).

Source: Isolated from soil.

Habitat Widely distributed in soil

8. Bacilius anthracis Cobn emend (Les infusories de la matadre charbonneuse, Davaine, Compt. rend. Acad Sci , Paris, 69, 1864, 393; Cohn, Beitroge z Biol d Pflanzen, 1. Heft 2, 1872, 177; Koch, sbid, 2, Heft 2, 1876, 279 : Bactéridie des charbon, Pasteur and Joubert, Compt. rend. Acad Sei., Paris, 84, 1877, 900; Bacterium anthracis Zopl. Die Spaltpilze, 2 Aufl., 1884, 45, Bacillus (Streptobacter) anthracis Schroeter, Kryptogamen Flora v. Schlesien, 3, 1, 1886, 163, Pollendera anthracis Trevisan, 1884, see Trevisan, I generi e le specie delle Batteriacee, 1889, 13, Bactersum anthracis Migula, in Engler and Prantl, Die natürlichen Pflanzenfam . 1, 1a, 1895. 21: Aplanobacter anthracis Erw. Smith, Bacteria in Relation to Plant Diseases, 1905, 171; Bacillus (Bacteridium) anthracis Buchanan, Jour. Bact , 5. 1918, 37.) From Greck, gen. of anthrax, charcoal, a carbuncle, the disease anthrax.

According to Smith, Gordon, and Clark (loc cit.) this species is a pathogenic variety of Bacillus cereus. They worked extensively with the latter but not with many strains of Bacillus and said seemed to be pathogeneity and motility, and some strains of Bacillus acreus are weakly pathogenic and some practically non-motile. It would appear that Bacillus cereus is a so-called parent species from which two varieties (var. anthracis and var. mycoides) and several morpho- and botypes have sprung.

Spores: Ellipsordal, 0.8 to 1 0 by 1.3 to 15 microus, central or paracentral, often in chains. Germination polar.

Sporangia: Ellipsoidal to eylindrical, not swollen, in chains.

Rods: 1.0 to 1 3 by 3 to 10 microns with square or ceneave ends, occurring in long chains, resemble Bacillus cereus. Cells from glucose or glycorol nutrent agar appear granular (vacuolated) if stained lightly; many fat globules presont. Nonmotule. Gram-positive

Gelatin stab. Arborescent in depth, inverted pine tree Liquefaction crateriform becoming stratiform.

Agar colonies: Large, irregular, dense, curled structure composed of parallel chains, similar to certain strains of Bacilius cereus.

Agar slant. Growth abundant, grayish, dense, spreading, with fimbriate borders. Broth: Little or no turbidity, thick pellicle.

Milk. Coagulated, slightly acid, peptonized.

Potato: Growth ahundant, spreading, white to ereamy.

Nitrates formed from nitrates. Starch is hydrolyzed.

Acid from glucose, fructose, sucrose, maltose, trhalose, and devtrin. Some strains produce late and slight acidity in glycerol and salicin. No definite formentation occurs in arabinose, rhamnose, mannose, galactese, lactose, raffinose, inulin, manifol, dulcitol, gorbitol, inosi-inulin, manifol, dulcitol, gorbitol, inosi-

tol, and adonitol (Stein, Vet. Med., 58, 1943).

Acetylmethylcarbinol produced.

Optimum temperature about 35°C. Maximum temperature allowing growth about 43°C.

Aerobic, facultative.

Pathogenic for man, cattle, swine, sheep, rabbits, guinea pigs, mice, etc. Source: From blood of infected animals. Habitat. The cause of anthrax in man.

cattle, sheep and swine.

9. Bacillus polymyza (Prazmowski) Migula. (Clostridium polymyza Prazmawski, Inaug. Diss., Leipzig, 1880, 37; Migula, Syst. der Bakt., 2, 1900, 638: Granulobacter polymyza Beijerinck, K. Akad. Wetenschap., Amsterdam, Sec. 2, 1, 1903, No. 10; Granulobacter polymyra var, mucosum and var, tenaz Beijerinck and Van Delden, Cent. f. Bakt., II Abt., 9, 1902, 13; further description by Gruber, Cent. f. Bakt., II Abt., 14, 1905. 353; Aerobacillus polymuza Donker, loc. cit, 138) From Greek poly, many or much: myza, slime or mucus.

This and the species immediately following (Bacillus macerans) are sometimes placed in the sub-genus Aerobacillus Donker emend. Kluyver and Van Neil (Donker, Inaug. Diss , Delft, 1926, 138; Kinvver and Van Neil, Cent. f. Bakt., H Abt , 94, 1936, 402; not Aerobacillus Pribram, Jour. Bact , 18, 1929, 374; not Aerobacillus Janke, Cent f. Bakt., II

Abt., 80, 1930, 481)

For a study of this group and a review of the literature see Porter, McCleskey and Levine, Jour. Bact., 55, 1937, 163. They give the following as synonyms of Bacillus polymyza: Bacillus asterosporus Migula (Astasta asterospora Meyer, Flora, Erg Bd , 84, 1897, 185, Migula, Syst. der Bakt , 2, 1900, 528, Aerobacillus asterosporus Donker, loc. cit, [41); Bacillus ovoaethylicus Pribram (Bacillus mycoides var. orogethylicus Wagner, Ztschr. f. Untersuch. d. Nahrungs- u Genussmittel, 31, 1916, 234; Pribram, Klassifikation der Schizomyceten, Leip-

zig und Wien, 1933, 86); Bacillus aerosporus Greer, Jonr. Inf. Dis., 43, 1928, 508.

Gottheil (Cent f. Bakt., II Abt , 7, 1901, 727) regarded the following as synonyms: Bacillus thalassophilus Russell, Ztschr. f. Hyg., 11, 1892, 190; Bacillus subanaerobius Migula, Syst. der Bakt, 2, 1900, 600.

Bredemann (Cent. f. Bakt., II Abt., 23, 1909, 45) admitted that the organisms. Bacillus asterosporus alpha, Bacillus dilaboides, and Bacillus clostridioides, named by Haselhoff and himself in an earlier article (Landwirtsch. Jahrh. 35, 1906, 420, 426, 432) were merely variants of Bacillus asterosporus.

The following is usually considered a variety or strain of Bacilius polymyza differing from the latter mainly in the production of a violet pigment on potato and agar in the presence of peptone: Bacillus violarius acetonicus Bréaudat, Ann. Inst. Pasteur, 20, 1906, 874 (Aerobacillus violarius Donker, Inaug. Diss, Delft, 1926, 141).

Also a probable synonym of Bacillus polymyza is Bacillus amaracrylus Viosc. net (Bacille de l'amertume, Voisenet, Compt. rend. Acad Sci., Paris, 155, 1911, 363; Voisenet, Ann. Inst. Pasteur, 32, 1918, 477; Aerobacillus amaracrylus Donker, loc. cet., 141). The chief character in which it differs from Bacillus polymyza is its ability to dehydrate glycerol with the formation of acrolein

Also a probable variant of Bacillus polymyza is Bacıllus pandora Corbet (Jour. Bact., 19, 1930, 321). The chief characters in which the latter differs from the former are the production of said without gas from glucose and the lack of

diastatic action.

Spores: Ellipsoidal, 10 to 15 by 15 to 2.5 microns, central to subterminal, wall usually thick and stainable. Freely formed.

Sporangia · Snollen, spindle-shaped (clostridia), sometimes elavate.

Rods 06 to 10 by 25 to 60 microns,

occurring singly or in short chains. Cells contain small fat globules when grown on glucose nutrient agar. Mottle with peritrichous flagella Gram-variable.

Gelatin stab: Slow liquefaction. Hydrolysis of gelatin always positive by Frazier technic.

Agar colonies: Thin, inconspicuous, lobed, spreading over entire plate Rough forms are round, whitish, and sometimes tough.

Agar slant . Crowth scant to moderate. indistinct to whitish. On glucose agar. the growth is much heavier, raised, cummy, glistening; gas is formed.

Broth: Uniform to granular turbidity, floceulent to slimy sediment Rough stage forms pellicle Final pH of glurose

broth cultures 5 2 to 68. Milk Not coagulated, gas usually

formed Milk agar plate Casein hydrolyzed

Potato · Growth moderate to abundant, whitish to light tan, potato decomposed with formation of gas Growth of rough stains is denser and heaped up.

Nitrites are produced from nitrates Starch is hydrolyzed. Crystalline dextrins are not produced.

Acid and gas (with ammoniacal nitrogen) from arabinose, xylose, glucose. fructose, galactose, roannose, maltose, sucrose, lactose, trehalose, cellobiose, raffinose, melezitose, dextrin. inulia. salicin, glycerol, and mannitol. Gum is also usually formed. Erythritol, adonitol, dulcitol and inositol not fermented. With organic nitrogen no acid or gas from rhamnose or sorbitol (Porter, McCleskey, and Levine, loc. cit., also Tilden and Hudson, Jour Bact., 43, 1942, 530) This, however, could not be confirmed by Smith, Gordon, and Clark (loc. est ) who found that acid and gas were produced from both carbohydrates.

Hemicellulose and pectin are attacked (Ankersmit, Cent. f. Bakt., I Abt., Oric . 40, 1905, 100). In glucose brothethyl alcohol and butylene-glycol are

produced also small amounts of acetone and butyl nlcohol. Acctylmethylcarbinol is produced.

Citrates usually not utilized as sole source of earbon

Outsmann temperature about 30°C. No growth at 42°C to 45°C; good growth at 20°C, slow at 13°C.

Not agglutinated by Bacillus macerans sera, results with homologous sera irregufar (Porter, McCleskey, and Levine, loc. cit ).

Aerobic, facultative

Source: First isolations were from grain, soil, and pasteurized milk

Habitat . Widely distributed in water, soil, milk, feces, decaying vegetables, etc.

In addition see Chester, Del. Agr Exp. Station, 15th Ann. Report, 1903, 65; Wund, Cent. f. Bakt., I Abt., Orig . 42, 1906, 193, 289, 385; Wahl, Cent. f. Bakt., II Abt., 16, 1906, 489; Ritter, Cent f. Bakt., II Abt , 20, 1908, 21; Meyer, Cent. f. Bakt., I Abt , Orig., 49, 1909, 305, Bredemann, Cent. f. Bakt., H Abt . 25. 1909, 41; Virtanen and Kurstom, Biochem Ztschr. 161, 1925, 9; Stapp and Zyeba, Arcb. f. Mikrobiol., 2, 1931, 493; Zveha, Arch. f. Mikrobiol., 5, 1032, 194; Patrick, Iowa State Coll Jour, Sci. 7. 1933, 407.

10. Bacillus macerans Schardinger. (Rottebazillus 1, Schardinger, Wiener Min. Woehenschr., 17, 1904, 207; Schardinger, Cent. f. Bakt., II Abt., 14. 1905, 772; Aerobactilus macerans Donker, Inaug. Diss , Delft, 1926, 139; Zymobacillus macerans Kluyver and Van Niel. Cent f Bakt, 11 Abt., 94, 1936, 402 ) From Latin macerans, softening, macerating or retting.

Porter, McCleskey, and Levine, Jour Bact., \$3, 1937, 163, regard the following as a synonym of Bacillus macerans; Bacillus acetoethulicum Northrup, Ashe. and Senior, Jour. Biol. Chem., 59, 1919. 1 (Aerobacillus acctoethylicus Donker, loc. cit.).

The following is probably a variant of

Bacillus macerans: Aerobacillus schuylkilliensis Eisenberg, Jour. Amer. Water Works Assoc. 34, 1912, 365. It is said to differ from Bacillus macerans in that sorbitol is not fermented, hydrogen sulfide is produced and gelatin is liquefied.

Spores: Ellipsoidal, 1.0 to 1 5 by 1.5 to 2.5 microns, terminal to subterminal; wall

thick and stainable.

Sporangia: Swollen terminally, clavate. Rods: 96 to 1.0 by 2.5 to 60 microns, occurring singly or in pairs, cells are larger on sugar media than on sugar-free media, and contain a few small fat globules. Motile. Gram-variable.

Gelatin stab: Liquelaction variable (see optimum temperature). Gelatin is hydrolyzed as determined by the Frazier

technic (30°C).

Agar colonies: Small, thin, transparent to whitish, irregular, usually smooth. Agar slant: Growth moderate, spread-

ing, inconspicuous.

Broth: Turbid, slight acdiment. In sugar broths some strains produce slime. Glucose broth cultures, pH 50 to 5.5.

Glucose broth cultures, pH 5 0 to 5.5.

Milk: Acid and gas. No visible

peptonization.

Milk agar plate Cascin not hydrolyzed in one week; later usually slight hydrolysis

Potato: Growth indistinct, gas is formed and the potato is digested.

Fruity odor sometimes produced.

Nitrites produced from nitrates.

Starch is hydrolyzed.

Acid and gas from arabinose, rhamnose, xylose, glucose, fructose, galactose, mannose, sucrose, maltose, lactose, trchalose, cellobiose, rafinose, meleritose, deatris, inuliu, saliciu, pectin, xylan, glycerol, mannitol, and sorbitol. Erythritol, adonitol, dulettol, and mositol not fermented (Porter, McCloskey, and Levine, loc. cit.)

Produces accione and ethyl but never butyl alcohol; ratio accione to alcohol is 1:2.

Acetylmethylcarbinol not produced.

Citrates not utilized as sole source of carbon.

Optimum temperature about 37°C Good growth at 42° to 45°C and sometimes slightly higher; poor growth, if any, at 20°C.

Differentiated from Bacillus polymara by the production of crystalline detrins from starch, lack of formation of acetyimethylearbinol, and by growth at 42°C to 45°C.

All strains agglutinated by homologous sera but not by Bacillus polymyza serum. Aerobic, facultative.

For additional literature, see Porter, McCleskey and Levine, Jour. Bact., 53, 1937, 180.

Source: Originally isolated from vats in which flax was retting.

Habitat: Widely distributed in soil, water, decomposing starchy materials, retting flax, etc.

11. Bacillus circulans Jordan. (Jordan, Exp. Inv., Mass State Board Health, Part II, 1890, 831; Bactenum circulans Chester, Ann. Rept. Del Col. Agr. Exp Sta., 9, 1897, 92, also see Ford, Jour. Bact., 1, 1016, 519.) From Latin circulans, making round or

circular. Smith, Gordon, and Clark (loc cit.) consider Bacillus circulans as a complex (see also Gibson and Topping, Soc. Agric. Bact. (British), Abstr. Proc., 1938, 43) because of the variations in the character of the growth and quantitative differences in physiology. All stages of growth may be found from the smooth actively motile strains that have motile colonies to the mucoid, non-spreading strains The species is more saccharolytic than proteclytie, considerable variation being found to its action on gelatin and casem. The following are regarded as variants: Bacillus closteroides Cray and Thornton, Cent. f. Bakt., II Abt., 73, 1928, 93; Bewegungstypus schwarmender Bakterien, Russ-Munger, Cent. f. Bakt., I Abt., Orig., 142, 1938, 175; Bacillus krzemieniewski

Kleczkowska, Norman and Snieszko, Soil Sci , 49, 1940, 185 (a mucoid variant).

Also probable variants : Bacıllus platus Soriano, Thesis, Univ. Buenos Aires, 1935, 572; Bacillus naviformis Soriano. ibid , 574 (not Bacillus naviformis Jungano, Comp. rend. Soc. Biol . Paris, 1. 1909, 122)

Spores: Ellipsoidal, 08 to 12 by 11 to 2.0 microns, terminal or subterminal. Spore wall thick and stainable. In some strains spores may be kidney-shaped and remnants of sporangium may adbere.

Sporangia Swollen terminally, clavate. Rods: 0.5 to 0.9 by 2.0 to 5.0 microns.

sometimes curved, usually occurring singly Cells contain small fat globules when grown on glucoso agar. Motile. some strains exceedingly so Gramvariable, usually negative.

Gelatin stab: Slow cone-shaped liquefaction, liquefied portion evaporating (Jordan): no liquefaction (Ford) Gelatin hydrolyzed if tested by the Frazier mathod.

Agar colonies: Thin, transparent, apreading over entire surface of plate. Often nearly invisible. The colonies of the rougher or mucoid strains are small, entire, whitish, non-spreading

Giant agar colonies If the surfaces of agar plates are dried before inoculation with very motile strains, instead of spreading as a thin layer of individual cells, minute rotating colonies proceed out from the edge of the colony, sometimes becoming entirely disconnected from it In moving out across the agar surface, non-motile cells are left behind. These may grow later. Eventually the whole plate is covered.

Agar slant Growth thin, transparent, spreading, becoming denser. Mucoid strains are dense, non-spreading, entire, gummy and adherent.

Broth. Light to fair turbidity with flocculent to slimy sediment Some atrains do not grow perceptibly. In glucose broth cultures the final plI is usually 5 ft to 5.8.

Milk. Usually acid, slowly coagulated. Milk agar plate: Casein not hydrolyzed. Weak hydrolysis with some strains

· Potato. Growth is very variable, from none to good growth, from colorless to vellowish, pink, or brownish.

Nitrites usually produced from nitrates.

Starch is hydrolyzed. Crystalline devtrins usually not formed

Acid without gas (with ammoniacal nitrogen) from glucose, fructose, mannose, galactose, sucrose, maltose, raffinose, salicin, and dextrin Usually acid from arabinose, xylose, lactose, glycerol, and mannitol. Reaction variable with rhampose and inulin

Acetylmethylcarbinol not produced. Citrates usually not utilized.

Methylene blue reduced and then reoxidized

Urease produced by some strains.

Optimum temperature about 20°C. Maximum temperature allowing growth. 40°C to 48°C A few strains will grow up to 52°C

This species is closely related to Bacil-Ins macerans from which It is distinguished by the lack of gas formation from carbohydrates and the lack of crystalline dexterns from starch. It is also close to Bacillus alies as indicated by the key.

Source. Found occasionally in tap nater, Lawrence, Mass. (Jordan)

Habitat Widely distributed in soil, water, and dust

12. Bacillus alvel Cheshire Cheyne (Jour. Roy Mic. Soc , Ser. II, 5. 1885, 592.) From Latin alreus, becbive

Probably identical with the above. Bacillus paraulte: Burnside, Amer. Bee Jour . 72, 1932, 433; Burnside and Foster, Jour. Econ Entomol, 28, 1935, 578.

Spores: Ellipsoidal, 0.7 to 1 0 by 1.5 to 25 microns, central to terminal. Free spores frequently lie in parallel arrangement like the rods.

bees.

Sporangia: Swollen, spindle-shaped to clavate.

Rods: 0.5 to 0.8 by 2 to 5.0 microns. Cells frequently lie parallel, side by side, like cartridges in a clip. Usually non-capsulated and very motile. Few small fat globules in cells from glucoso agar. Gram-variable (young cells Gram-positive, becoming Gram-negative).

Gelatin stab: Slow liquefaction.

Agar colonies: Thin, translucent, smooth, quickly spreading as a thin layer over entire plate. The growth thickens with age. Rough and mucoid strains do not spread.

Giant agar colonies: If the surfaces of agar plates are dried before inoculation with the motile strains, instead of spreading as a thin layer, munute bullet-shaped colonies proceed out from the edge of the colony and move across the sterile agar. Non-motile and sometimes motile cells are left behind along the path made by the motile colony (Smith and Clark, Jour. Bact, 35, 1938, 59). Eventually the whole plato is covered.

Agar slant Growth thin, inconspicuous, spreading, becoming thicker. Rough

strains may form a pellicle Glucose broth cultures have a pH of 5.0 to 60. Milk: Usually coagulated, little or no acid, peptonized

Milk agar plate Casein hydrolyzed. Potato . Growth scant to moderate, soft,

spreading, usually creamy yellow.

Nitrites not produced from nitrates Starch is hydrolyzed

Acid (with ammoniacal nitrogen) from glucose, fructose, galactose, sucrose, maltose, destrin and glycerol. Reaction variable on mannose, factose, ruffinose, salicin, and manutol. No acid from arabnose, rhamnose, xylose, and inulin. Acetylmethylcarbinol is produced.

Citrates not utilized

Optimum temperature about 30°C.

Maximum temperature allowing growth 43°C to 45°C.

Putrefactive odor on media rich in proteins (egg), Acrobic.

Source: Isolated from diseased broad of

Habitat: Associated with European foulbrood of honey bees; widely distributed in soil.

Note: The following must be considered in connection with Bacillus alies:

Bacillus pluton White. (U. S. Dept. of Agric., Bur. Entomol., Circ. 157, 1912; Diplococcus pluton Bergey et al., Manual, 2nd ed., 1925, 45)

See also Lochhead, Science, 67, 1928, 159 and Proc. IV Intern. Congr. Entomol. 2, 1929, 1005; Burnside, Jour. Eco Entomol., 27, 1923, 556; Tarr, Ann. Appl. Biol., 21, 1925, 614; Burn, Beiheite r. schweiz. Beinenz., 1, 161; 1, 1941.

White considered Bacillus pluton to be the cause of European foulbroad though the evidence was indirect since theorem. ism was not cultivated. Lockhead suggested that Bacillus pluton and Streptococcus opis are variants or stages in the life history of Hacillus alrei, a hypothesis supported by Burnside who included, in addition, Bacterium eurydice. According to Burri, rod forms identical with Bacterium eurydice give rise to Bacillus pluton which is not directly cultivable Tarr considers European foulbrood to be caused by Bacillus pluton, distinct from Bacillus alvei, and considers it a strict parasite able to multiply only in the intestines of young larvae.

Source: Larvae of the honey bee infeeted with European foulbrood.

13. Bacillus laterosporus Laubach.
(Jour. Bact., 1, 1916, 511.) From Latin
latus, lateris, the side; Greek aperus,
seed; M.L., spore.

Synonym: Bacillus orpheus White. (U. S. Dept. of Agric., Bur. Entomol., Circ. 157, 1912, 3) Although named by White, the organism was not described until 1917 (McCray, Jour. Agr. Research, 8, 1917, 410). Resembles Bacillus laterosporus (White, U. S. Dept Agric. Bull. 810, 1920, 14). According to the rules of priority, the name to be used is Bacillus laterosporus

Spores. Ellipsoidal, 10 to 13 by 12 to 15 microns, central to subterminal, formed close to one side, remnants of the sporangium adhering to the other side

Sporangia: Swollen, spindle-shaped

Rods · 0 5 to 0.8 by 2 0 to 5 0 microns, occurring singly and in pairs Ends pointed or poorly rounded Cells from glucose nutrient agar may have few small fat globules Motile Gram-variable.

Gelatin stab · Slow liquefaction
Agar colonies Thin, transparent, irreg-

Agar colonies Thin, transparent, irregular, spreading Colonies of rough strains are small, round, convey, nonspreading

Agar slant: Growth moderate, flat, translucent to opaque, moist, sometimes with a silvery sheen

Broth Uniform to granular turbidity, usually no pellicle Glucose broth cultures, pH 0 0 to 6 4.

Milk Usually curdled, peptonized Milk agar plate Occasionally weak hydrolysis of casein

Potato Growth thin, spreading, grayish to pinkish, turning light brown with age Sometimes finely wrinkled.

Nitrites produced from nitrates Starch is not hydrolyzed.

Acid (with aminoniacal nitrogen) from glucose, fructose, maltose, glycerol, and mannitol Reaction variable on galactose, mannose, and salicin. No acid from arabinose, rhamnose, xylose, sucrose, lactose, raflinose, nulin, and devirin

Acetylmethylcarbinol not produced Citrates not utilized as sole source of

carbon.

Optimum temperature about 28°G

Maximum temperature allowing growth

37°C to 45°C Aerobie.

Source Isolated from water Habitat: Widely distributed in soil, water and dust. 14. Bacillus brevis Migula emend Ford (Bacillus No. J. Flogge, Zischr. I, Hyg. 17, 1894, 294, Bacillus lactis No. I, Krune, in Higge, Die Mikroorganismen, 3 Aufl., 2, 1800, 208, Migula, Syst. d. Bakt., 2, 1800, 583, not Bacillus brevs Frankland and Frankland, Microorganisms in Water, 1894, 429, Bacillus fåogge Chester, Man Determ. Bact, 1901, 281; Ford, Jour Bact., 7, 1916, 522) From Lattin bretis, short.

Synonym · Bacillus centrosporus Ford, Jour. Bact , 1, 1916, 524.

There is some doubt as to the identity of Migula's Bacillus brevis which originally was Flugge's Bacillus No. I. Neide (Cent. f. Bakt., II Aht , 12, 1904, 337) also renamed Flugge's organism. He called it Bacillus lactis and described it sufficiently that it may be recognized as a strain of Bacillus cereus. Ford helieved that his isolations from milk, soil and dust conformed to Migula's description of Bacillus breiis. Ford's interpretation has been accepted. The species has apparently become well established in Europe (Gibson and Topping, Soc. Agric. Bact. (British), Abstr. Proc., 1938, 43) as well as in America.

Description from Ford and from Smith, Gordon, and Clark (loc cit.)

Spores. Ellipsoidal, 10 to 13 by 15 to 20 merons, central to subterminal Spore walls thick and attainable. An occasional attain shows the relationship of this species to Bacillus laterosporus in that some of the spores may be lateral and remunants of the sporangia may adhere to one side of the spore.

Sporangea Definitely swollen, spindleshaped to clavate

Rods: 0 4 to 0 8 by 1 5 to 50 microns, with pointed ends, occurring singly or in pairs. On glucose agar cells contain numerous small fat globules. Motile. Gram-variable

Gelatin stah Slow liquefaction.
Agar colonies: Thin, flat, translucent,

smooth, quickly spreading over plate.

Agar slants: Growth smooth, moist,
spreading gravish white.

only at higher temperatures and under anaerobic conditions. Migula called this Bacillus pseudotetanicus. Ford (Jour. Baet., 1, 1916, 520) stated that this name had priority over Neide's Bucillus sphaericus which he thought was identical. On the other hand, Tavel Goc. cit.) isolated a pseudotetanus bacillus that was apparently anacrobic. Its spores were ellipsoidal and it formed more gas than the tetanus bacillus, Migula named this organism Bacillus pseudotetani. Subsequently Migula's names have been applied to the aerobic organism. Bacillus pseudotetanicus and Bacillus pseudotetani are nomina dubia and Bacillus sphaericus should therefore be used.

Spores: Spherical, 0.7 to 13 microns in diameter, terminal to subterminal. Young spores in sporangia may be oval. Spore will thick; remnants of sporangium may adhere.

Sporangia: Definitely swollen, clavate to spindle-shaped.

Rods: 0 0 to 1.0 by 1.5 to 7.0 microns, occurring singly or in short chains. On a glucose agar cells contain few small fat globules. Motile. Gram-variable; often Gram-negative with Gram-positive granules.

Gelatin stab: Scant growth No liquefaction. Gelatin hydrolyzed if tested by the Frazier technic.

Agar colonies: Small, thin, flat, translucent, often spreading over the plate.

Giant agar colonies. If the surface of the agar is fairly dry, many strains exhibit minute colonies that swarm out from the point of inoculation and cover the plate (cf. Bacullus alses and Bacullus circulans).

Agar slants: Growth thin, smooth, spreading, translucent, becoming yellowish brown Growth occurs at pH 6.0

Broth: Uniform turbidity. Glucose broth cultures have pH of 8 3 to 8 6 after 7 days

Milk · No change

Milk agar plate Scant, if any, hydrolysis of casein. Potato: Growth scant, thin, spreading, soft, gray, becoming yellowish-brown with age.

Nitrites not formed from nitrates. Starch not hydrolyzed.

No acid from carbohydrates.

Acetylmethylcarbinol not produced. Citrates not utilized.

Urease not formed.

Salt tolerant. Growth occurs in broth containing 4 per cent NaCl.

Optimum temperature about 30°C. Maximum temperature allowing growth 40°C to 45°C.

Not pathogenic for guinea pigs. Aerobic, facultative.

Source: From mud of a pond, rotting eypress wood, rotting oak wood, and from soil.

Habitat: Widely distributed in nature. Bacillus rotans Roberts (Jour. Bact, 29, 1935, 229) differs from Bacillus sphaericus in that it will not grow as low as pH 6.0 nor in broth containing 4 per eent NaCl. Originally characterized by motile colonies, this phenomenon has been noted with certain other members of the gebus and with some strains of Bacillus sphaericus. Smith, Gordon, and Clark (loc. cit.) consider it a variety of Bacillus sphaericus sphaericus.

Source: From intestine of a termite Habitat: Probably widespread in soil

18a. Bacillus sphaericus var. fusiformts comb. nov. (Bacillus fusiformis Gottheil, Cent. I. Bakt., II Abt., 7, 1901, 724.) From Latin fusus, spindle; formis, shape

This organism differs from Bacillus aphaericus only in that it produces urease. Source: One strain isolated from Belovulgaris lules (beet). Also from milk, dust, soil and contaminated hirudin.

Habitat Widely distributed in nature Bacillus lochnisis Gibson (Jour. Bect., 29, 1935, 495) is very closely related to the above It will not grow at pH 60 or below, prefers media containing uro, and produces nitrites from nitrates. Gibson (Joc. cit., 500) in discussing the

organisms of this group stated "each species contains strains dissimilar in several features and each is connected to the others by transitional forms". Smith, Cordon, and Clark (loc cit.) tentatively have placed it as a variety of Bacillus sphareticus

Source · From soil.

Habitat: Widely distributed in soil

19 Bacillus pasteurit (Miquel) Chester. (Urobacilus pasteurit Miquel, Ann Micrographue, 1, 1889, 552; sive Bacillus urace, third, 2, 1899, 13, 53, 122, 145, 367, 485; Chester, Ann. Rept Del Col Agr. Exp Sta., 10, 1898, 110) Named for the French scientist, Louis Pasteur (1822-1895)

Vichover, Cent. I Bakt., II Aht, 89, 1913, 200, gave the following as possible synonyms 'Urobacillus maddozir Miquel, Ann Micrographie, 8, 1891, 275 and 305 (Bacterium moddozi Chester, Ann Rept Del Col. Agr Exp Sta. 9, 1897, 98; Bacillus maddozi Chester, shid. 10, 1898, 110); Urobacillus leuber Beijerinek,

Cent. f Bakt . II Abt . 7, 1901, 51 Synonyms according to Cibson, Jour Baet , 29, 1935, 494 and 496: Bacillus probatus Viehover, Cent f Bakt , II Abt .. 59, 1913, 209; Urobacillus psychrocartericus and Urobocillus hesmogenes Rubentschik, Cent f Bakt, II Abt., 66. 1925, 166 (Bocillus psychrocartericus and Bacillus hesmogenes Bergey et al., Manual, 3rd ed , 1930, 403, 404) Cibson also included the following as possibly identical with the above although they were incompletely described · Bacillus ureae II and III Burn, Herfeldt and Stutzer, Jour Landw., 42, 1891, 329; Urobacillus duclauxu Miquel, Ann Micrographie, 2, 1890, 53, 122, and 145; Urobacillus maddox11 Miquel, 1b1d , 3, 1891, 275 and 303.

Description taken from Löhnis and Kuntze, Cent. f. Bakt., II Abt., 20, 1908, 681; Gibson, Jour. Bact., 28, 1934, 295 and 313, Smith, Gordon, and Clark (for. cit.).

This species has been designated as the type species of the genus Urobacillus Miquel (Ann de Micrographie, 1, 1889, 517) by Enlows (U. S. Pub. Health Scr., Hyg. Lab. Bull. 121, 1920, 96).

Spores: Spherical, 10 to 1.2 microns, terminal to subterminal.

Sporangia: Prevailingly clavate. Not in chains.

Rods: 0.7 to 0.8 by 1.5 to 2.0 microns (1.0 to 1.5 by 4.0 to 5.0 microns, Löhnis and Kuntze), occurring singly or in pairs. Motile Cram-variable.

Urea gelatin stab: Slow liquefaction.
Urea agar colonies: Small, entire, not
characteristic.

Urea agar slope: Crowth thin, very little apreading, colorless or white to yellowish. 'Will not grow'at pH 60 or

less.

Urea broth: Moderate to heavy uniform turbidity. Will grow with 4 per

cent NaCl added
Nitrites produced from nitrates in urea nitrate nutrient broth.

Starch not bydrolyzed.

Carbohydrates not attacked.

Acetylmethylcarbinol not formed,

Urease produced.

Optimum temperature about 30°C, minimum 6°C. Maximum temperature allowing growth 40°C in water bath. Optimum temperature for urease activity 50°C

Aerobic

The distinguishing character of this species is that growth occurs only in peptone media containing urea or free ammonia under neutral or alkaline conditions

Source From decomposing urine.

Habitat · Widely distributed in soil, dust, manure, and sewage.

20. Bacillus thermoamylolyticus Coolhaas (Cent f. Bakt, II Abt., 75, 1928, 341) From Greek thermos, hot, amylon, starch, and lytikos, able to loose, hence, dissolving Probably intended to mean thermophilic and starch digesting.

Spores: Slightly elongated, ellipsoids 0 6 by 1 5 microns, central

o Goy 1 5 microns, centr

Sporangia: Cylindrical, not swellen, not in chains

Rods: 0.6 by 5 to 8 microns. Motile. Gram-positive.

Gelatin stab : No liquefaction.

Agar colonies: At 60°C of two types, large and small, circular, translucent, granular, slimy,

Broth: Very weak growth, no surface growth, no sediment.

Milk: Not coagulated, slowly peptonized.

Potato: Slight growth.

Nitrites produced from nitrates. Starch actively hydrolyzed.

Acid and gas from glucose, fructose, galactose, maltose, dextrin, starch and glycerol. Arabinose, xylose and mannitol not fermented

Thermophilic, optimum temperature 50° to 55°C.

Aerobic.

Source: From sewage.

Habitat: Probably in decaying matter.

21. Bacillus kaustophilus Prickett. (N. Y. Agr. Exp. Sta. Tech. Bul. 147, 1928. 33 ) From Greek kaustás, burnt.

red-hot; philos, loving; heat loving. Spores: Ellipsoidal, 05 by 06 to 0.8 micron, terminal to subterminal. No free spores observed.

Sporangia: Only slightly swollen if at all.

Rods: On yeast extract-nutrient agar at 56°C, 07 by 2.0 to 45 microns, with rounded ends. Actively motile. Grampositive.

Gelatin stab: No growth at 20°C. Liquefied at 56°C.

Agar coionies: At 56°C, circular, convex, smooth. Borders entire to irregular. Show curled structure, strands of chains Brown by transmitted light.

Agar slant: Growth abundant, raised, glistening, contoured, bluish-green to bluish-white by transmitted light. After three weeks at 37°C, growth has a distinct reddish-brown color, butyrous, viscid. Broth. Slightly turbid, no sediment.

No surface growth, alkaline.

Litmus milk: Rennet coagulum, peptonization feeble, litmus reduced.

Po tato: Amount of growth variable, brownish, sprending, glistening, slimy Some strains do not grow.

Nitrites produced from nitrates, often with the production of nitrogen

Starch is hydrolyzed.

Acid from glucose and salicin. Rhamnose, maltose, sucrose, raffinose, mannitol, sorbitol and inulin not fermented

Acetylmethylcarbinol not produced Thermophilic, optimum temperature

60°C to 65°C. Growth at 73°C to 75°C but none at 80°C on agar slants.

Aerobic, facultative,

Good growth occurs in synthetic media containing potassium nitrate, sodium ammonium phosphate, aspartic acid, and sodium asparaginate, respectively, as only sources of nitrogen with glucose as source of carbon

Source: Forty-eight cultures isolated from posteurized milk at a single milk plant (Buffalo, N. Y.).

Habitat: Probably originally from soil and dust.

Thermobacillus digestans Feirer (Soil Sci., 23, 1927, 50) seems to be closely related to the preceding. It is more strongly proteolytic, digesting milk completely in 7 days.

Source: Four strains isolated from soil.

21a. Bacillus pepo Shaw. (Jour. Inf. Dis . 45, 1928, 473.) From Cucurbita pepo, the pumpkin.

From the brief original description, this organism seems to vary from Bacillus kaustophilus only in its distinctive viscid

or slimy character. Source. Two cultures isolated from swelled cans of pumpkin.

Habitat: Probably found in soil and

dust. 22. Bacillus thermoindifferens Wein-(Jour. Med. Research, 39, 1919, 402.) From Greek thermos, hot and

Latin indifferent, indifferent. Indifferent to or tolerant of heat. Spores. Ellipsoidal, 0 5 by 0 8 micron,

termmal.

Sporangia: Cylindrical, not swollen. Rods: 0.7 by 2.0 to 4 5 microns, occurring singly and in short chains, with rounded ends. Motile. Gram-positive. Gelatin stab: Growth filiform. Slow

Agar colonies Circular, convex, smooth, entire, amorphous Agar slant Growth flat, spreading,

infundibuliform liquefaction.

Agar slant Growth flat, spreading, glistening, translucent, butyrous, contoured.

Broth: Turbid, abundant sediment. No surface growth

Latmus milk: Alkaline Litmus reduced.

Potato: No growth.

Indole not formed

Nitrites not produced from nitrates Starch is hydrolyzed.

Acid from glucose No acid from lactose, sucrose or mannitol.

Thermophilic, optimum temperature 55°C Grows at 20° to 37°G.

Aerobic Source · Isolated from canned pumpkin. Habitat Probably found in soil and

Thermobacillus reductans Feirer (Soil Sci. 83, 1027, 51) is said to resemble Bacillus thermoindifferens except that nitrites are formed from nitrates and the minimum temperature is 40°C.

Source: Two strains isolated from soil Thermobacillus catenatus Feirer (Soil Sci, 28, 1927, 53) may be related to this group. The description is very incomplete. Its distinctive feature is the production of indole

Source Two strains isolated from soil.

23 Bacilius thermodiastaticus Bergey et al. (Type I, Bergey, Jour Bact., 4, 1919, 301, Bergey et al., Manual, ist ed., 1923, 310) From Greek thermos, hot and dustatitos, separative; M. L., enzymatic, diastatic; hence dustatic at high temperatures.

Spores Of less dameter than that of

the rods, ellipsoidal, central

Sporangia: Cylindrical.

Rods: 05 to 07 by 2 to 3 microns,

occurring in chains, with square ends.

Motile with peritrichous flagella. Gramnositive.

Gelatin etah: Liquefaction.

Agar colonies: Grayish, spreading, with lobate to fimbriate borders.

Agar slant: Growth thin, limited, hluish-gray.

Broth: Turbid.

Litmus milk: Not congulated, peptonized
Potato: Growth slight, grayish.

Nitrites produced from nitrates

Starch is hydrolyzed

Thermophilic, optimum temperature 65°C. No growth at 50°C. Growth at 75°C.

Aerobic.

Source: Isolated from dust and contammated milk.

Habitat: Probably widely distributed in soil and dust.

Thermobacillus diastassus Feirer (Soil Sci, 23, 1927, 49) differs from Bacillus thermodiastaticus only in that nitrites are not formed from nitrates (Feirer).

Source: Two strains isolated from soil.

24 Bacillus cylindricus Blau. (Cent. f. Bakt, II Abt, 18, 1905, 119) From Greek kylindrikos, cylindrical

Spores: Somewhat elongated, 0.7 to 1 I by 18 to 2.5 microns, terminal. Remnants of sporangium adherent. Germination equatorial and oblique

Sporangia Cylindrical or only slightly swollen at end, not in chains

Rods: On glucose agar at 60°C, 0.8 to 11 by 50 to 7.5 mecrons, occurring singly and in pairs. Motile with peritrichous flagella. Cells store glycogen. Gram-positive

Gelatin stab No liquefaction

Glucose agar colonies: Grayish-white, entire to lobed to dentate. By transmitted light yellowish-brown centers with brownish-yellow borders. Finely fibrous structure.

Glucose agar slant: Growth thin, dull, grayish-white.

Litmus milk: Unchanged.

Potato: No growth.

Nitrites not produced from nitrates. Starch not hydrolyzed.

Thermophilic, optimum temperature 60°C to 70°C.

Source: Isolated from moist field soil in Germany.

Habitat: Probably found in dust and soil.

Bocillus calidus Blau (Cent. f. Bakt., II Abt., 15, 1905, 134) differs so little from the preceding species that it cannot be considered as distinct.

Source: Isolated from field soil in Germany (Blau). Dust, ground feeds, etc., about dairies and various dairy products (Prickett, N. Y. Agr. Exp. Sta. Tech. Bul, 147, 1928, 45),

25. Bacillus robustus Blau. (Cent. f. Bakt., II Abt., 15, 1905, 126.) From Latin robustus, oaken, hard, firm.

Spares, Ellipsoidal, 1.0 by 1.6 to 2.2 microns, polar to medial. Remnants of sporangium not adherent. Germination prevailingly equatorial.

Sporangia. Ellipsoidal to cylindrical.

not in chains.

Rods: 1.0 to 1.2 by 3 to 4 microns, occurring singly and in short chains. Motile, Gram-positive.

Glucose agar colonies. Circular, graywhite. By transmitted light brownishvellow. Borders distinct, serrate to

lobed, finely granular.

Glucose agar slant: Growth yellowishwhite, translucent, becoming grayishwhite, spreading, dull.

Potato: Growth yellowish-white, moist,

glistening, smooth.

Nitrites not produced from nitrates. Starch not hydrolyzed.

Thermophilic, optimum temperature 55°C to 60°C. Grows at 65°C.

Aerobic.

Source: Isolated from field soil near a forest in Germany.

Habitat · Probably found in soil and dust.

Thermobacillus restatus Feirer (Soil Sci., 23, 1927, 51) is said to correspond in some respects with Bacillus robustus. Feirer states that it is not possible to definitely establish the identity because Blau failed to record the action of Bacillus robustus on nitrates and several other media and did not note the production of H.S.

Source: Three strains isolated from lioa.

25a. Bacillus losanitchii Bergey et al. (Bacillus thermophilus losanitchii Georgevitch, Cent. f. Bakt., II Abt., 27, 1910, 164; Bergey et al., Manual, 1st ed , 1923, 313.) Named for Losanitch, near Vranje.

As far as can be determined from the meager description, this organism does not differ from Bacillus robustus except perhaps as to the maximum temperature allowing growth. Growth limits are 45°C to 78°C.

Source: Isolated from water of bot sulfur spring. Temperature of water 83°C.

Habitat: Probably in natural hot waters.

Norn: Georgevitch (Arch. f. Hyg., 72, 1910, 201) has described a thermophilic nerobic spore-forming sulfur bacillus from a hot sulfur spring at Vranje (Servia) under the name Bacillus thermophilus pranjensis. This does not grow on ordinary media unless sulfur compounds are added. It has a tuft of flagella at either end. Spores are ellipsoidal, terminal, distend the rod, and show polar cermination

Georgevitch (Cent. f. Bakt., II Abt, 27, 1910, 150) describes a second thermophilie, metile, capsulated, ellipsoidalspored rod from a chalybeate hot spring near Vranje under the name Bacillus thermophilus jivoini

26 Bacillus calidolactis Hussong and Hammer. (Jour Bact., 15, 1928, 186.) From Latin calidus, warm, hot and lac, lactis, milk

Gorini states (R. Ist. Lombardo Sc. t. Lett. Rend , 76, 1942, 3) that Bacillus calidolactis is the same organism as Bacillus lactis termophilus (sic) Gorni (Giorn. d. R. Soc. Ital d'Ignene, 16, 1894, 16). From the descriptions this appears to be probable

Spores. Ellipsoidal, of slightly greater diameter than the rods, terminal.

Sporangia: Slightly swollen, clavate Rods 07 to 14 by 26 to 50 microns, occurring singly, in pairs and short chains Non-motile. Gram-positive, some cells becoming Gram-negative with are.

Gelatin stab; No liquefaction

No growth on plain nutrient agar Glucoso agar colonies Thin, white,

opaque, filamentous Glucose agar slant; Growth abundant,

echinate, dull, white
Glucose agar stab. Growth abundant,

beaded, gray

Glucose broth. Turbid

Litmus milk Acid, congulation. Intmus reduced

Potato: No growth.

Nitritos produced from nitrates by some strains

Acid from glueose, lactore, fructose, galactose and maltose No acid from inulin, sucrose or glycerol.

Thermophilic, optimum temperature 55°C to 65°G No growth at 37°G Aerobic, facultative

Source' Isolated from normal pasteurized skim milk (Hussong and Hammer). Milk and milk powder (Prickett, N Y Agr Exp Sta Tech Bul 147, 1928, 47) Habitat Probably in dairy products

27 Bacilius michaelisti Prickett (Bacilius thermophilus aquatilis lique-factens Michaelis, Arch. f. Hyg., 58, 1899, 285; Prickett, N. Y. Agr. Exp. Sta. Tech. Bul. 147, 1928, 45.) Named

for Georg Michaelis of Berlin who first isolated the species Spores Of greater diameter than the rods, terminal.

Sporangia: Swollen, clavate.

Rods 06 to 0.8 by 2 to 4 microns. Motile Gram-positive. Gelatin stab: Liquefaction.

Agar colonies: Circular, raised, smooth, glistening

Agar slant: Growth moderate, smooth,

Broth. Slight turbidity.

Milk. Not coagulated, alkaline

Potato: Growth moist, glistening, yellowish, becoming brownish

Natrites with gas produced from

Starch is hydrolyzed.

Acid from glucose and sucrose. No acid from rhammose, maltose, lactose, glycerol, mannitol or mulin.

Thermophilic, optimum temperature 50°C to 60°G

Aerobic, facultative

Source. Isolated from fountain waters (Michaelis) From fodder, dust, dairy utensils (Prickett)

Habitat. Probably found in soil and dust

27a Bacilius lobatus Bergey et al. (Type 3, Bergey, Jour Bact , 4, 1919, 304; Bergey et al , Manual, 1st ed., 1923, 311.) From Greek lobatos, having the form of a lobe.

Judging from the meager description, there is no essential difference between this organism and the preceding.

Source Isolated from dust, soil, and horse manure.

Habitat: Probably widely distributed in soil and decaying matter.

Bacillus nondiastaticus Bergey et al. (Type 2, Bergey, Jour Bact , 4, 1919, 304; Bergey et al , Manual, 1st ed , 1923, 310) From Greek, no diustase.

The description of this organism is practically identical with Bacillus lobatus, the only difference noted being that this species hydrolyzes starch while Bacillus nondiastaticus does not

Source: Isolated from dust and soil (Bergey). Ground grains, raw and pasteurized milk (Prickett, N. Y. Agr. Exp. Sta. Tech. Bul. 147, 1923, 47).

Thermobacillus vulgaris Feirer (Soil Sci , 23, 1927, 50) liquefies gelatin, does not reduce nitrates to nitrites nor alter litmus milk. According to Feirer it is otherwise similar to Bacillus nandiastaticus.

Source: Two strains isolated from soil.

27b. Bacillus thermononliquefaciens Bergey et al. (Type 4, Bergey, Jour. Bact , 4, 1919, 301; Bergey et al., Manual, 1st ed., 1923, 312.) From Greek thermos. hot; and Latin non, not and liquefaciens, making liquid. Probably intended to mean thermophilic and non-gelatinliquefying.

Aside from the non-liquefaction of gelatin, there seems to be no difference in the description of this organism and the two immediately preceding.

Source: Isolated from dust, soil, and horse manure.

Habitat · Probably found in soil and decaying matter.

. 28. Bacillus thermotranslucens Bergey et al. (Type 5, var b, Bergey, Jour. Bact , 4, 1919, 304; Bergey et al., Manual, 1st ed., 1923, 312 ) From Greek thermos, hot and Latin translucens, translucent Probably intended to mean thermophilic and translucent.

Spores: Of larger diameter than the rods, terminal.

Sporangia: Terminally swollen, clavate, not in chains.

Rods: 03 to 04 by 1.0 to 15 microns, occurring singly. Motile with peritrichous flagella. Gram-positive.

Gelatin stah: No liquefaction.

Agar colonies: Thin, transparent, spreading widely.

Agar slant Growth thin, spreading, veil·like.

Broth, Turbid

Litmus milk Not coagulated, slightly acid.

Potato: No growth.

Nitrates not produced from nitrates.

Starch slightly hydrolyzed. Thermophilie, optimum temperature

60°C Slight growth at 37°C No growth at 70°C.

Aerobic.

Source: Isolated from guinea pig feces, dust and from cheese.

Habitat: Probably found in soil and

decaying matter.

Thermobacillus linearius Feirer (Soil Sci., 23, 1927, 53) is said to be similar in some respects to the preceding. Feirer states that formation of acid from several sugars is the distinctive feature of this species, a character not mentioned by Bergev.

Source: Five strains isolated from soil.

28a Bacillus stearothermophilus Donk (Jour. Bact , 5, 1920, 373 ) From Greek stear, tallow and thermophilos, heat-Intended meaning obscure loving

From the descriptions, the vegetative rods of this organism seem to be slightly larger than the preceding, otherwise to difference is noted.

Source: Isolated from samples of spoiled canned corn and string beans. Habitat: Probably found in soil and dust.

28b. Bacillus aerothermophilus Weinzirl. (Jour. Med. Research, 59, 1919, 403.) From Greek acros, air and thermophilus, heat-loving. Probably intended to mean aerobic and thermophilic

There is nothing in the original account of this organism which is at variance with that of the preceding.

Source Isolated from canned string beans (Weinzirl). From milk, water, hay, dust, beef extract, and agar (Prickett, N. Y. Agr. Exp. Station Tech. Bull. 147, 1928, 46).

Habitat: Probably found in soil and dust.

Thermobacillus alcalinus Feirer (Soil Sei., 23, 1927, 52) is said to differ from the preceding in that it does not change litmus milk.

Source · Four strains isolated from soil. Thermobacillus ruber Feirer (Soil Sci, 23, 1927, 52) apparently is closely related to this group. Its distinguishing character is the production of a pink pigment

in meat, brain, and blood serum, no color on other media.

Source, Isolated from soil

29. Bacilius thermocellulolyticus Coolhass. (Cent. f. Bakt., II Aht., 78, 1928, 43.) From Greek thermos, hot; and Latin cellula, a small room; M. L., cellulose and Greek tylikos, dissolving Probably intended to mean thermophilic and cellulose-directing.

Spores. Ellipsoidal, 0 8 by 1 5 microns, terminal.

Sporangia Terminally swollen, clavate Rods: 0 3 by 3 5 to 6 microns, occurring singly and in pairs. No reserve material

Non-motile. Gram-positive.

Gelatin stab: No liquefaction. Glucose agar colonies: Small, glistening, translucent

Cellulose agar colonies. Circular, borders undulate to lobate.

Broth · Slight growth, no surface growth or sediment.

Milk No growth

Nitrites not produced from nitrates. Starch is hydrolyzed. No acid from carbohydrates.

Cellulose hydrolyzed
Thermorphilic ontimum

Thermophilic, optimum temperature 50°C to 55°C Maximum 60°C to 65°C Minimum 35°C to 37°C

Acrobie, facultative.

Source Isolated from sewage Habitat · Probably found in decaying matter

30 Bacillus thermoalimentophilus Weinzirl (Jour. Med. Research, 59, 1919, 404) From Greek thermos, hot, Latin alimentum, food; and Greek philos, loving Loving hot food

Spores Ellipsoidal, 0.8 by 1.0 micron, terminal.

Sporangia: Swollen, clavate, not in chains

Rods. 06 by 30 microns, occurring singly, with rounded ends. Motile, flagella not stated. Gram-positive

Gelatin stab . No growth at 20°C.

Agar colonies: Circular, raised, 8ni00th, amorphous, entire

Agar slant Growth spreading to effuse, smooth, glistening, hutvrous.

Broth · Turbid, surface ring.

Litmus milk: Unchanged

Potato: No growth.

Nitrites with gas produced from nitrates

Starch not hydrolyzed.

Neither acid nor gas from glucose, lactose, sucrose or mannitol.

Thermophilic, optimum temperature 55°C. No growth at 20°C. Growth at 37°G.

Aerobie.

Source: Isolated from canned blueberres (Weinzirl). Pasteurized milk and filter cloth (Prickett, N. Y. Agr Exp Sta Tech Bul. 147, 1923, 46).

Habitat: Probably found in soil and dust

Thermobacillus violaceus Ferrer (Soil Sen., 23, 1927, 52) corresponds in some respects with the preceding. Feirer also states that his cultures did not reduce nutrates to nutrities and produced acid on plucose and sucrose.

Source · Four strains isolated from soil.

31. Bacillus thermoliquefaciens Bergey et al. (Type 5, var a, Bergey, Jour. Bact., 4, 1910, 304; Bergey et al., Manual, Ist ed., 1923, 313.) From Greek thermos, hot, and Latin liquefaciens, liquefying. Probably intended to mean thermophilic and gelatin-lique(j)ing.

Spores Ellipsoidal, polar, of greater diameter than the rods.

Sporangia Terminally swollen, clavate. Rods: 0.2 to 0.4 by 2 to 3 microns, occurring singly, with rounded ends.

occurring singly, with rounded ends. Motile with peritrichous flagella. Grampositive

Gelatin stab Liquefaction.

Agar colonies: Moderately dense, lobate.

Agar slant: Growth dense, grayish, lobate to fimbriate margins.

Litmus milk: Coagulated, acid. Litmus reduced. Potato: No growth.

Nitrites and ammonia produced from nitrates.

Starch not hydrolyzed.

Thermophilic, optimum temperature 50°C. Slight growth at 37°C. No growth at 70°C.

Aerobic.

Source: Isolated from dust, guinea pig feces and horse manure (Bergey). Water and milk (Prickett, N. Y. Agr. Exp. Sta. Tech. Bul, 147, 1928, 47).

Habitat: Probably originally from soil

nd dust.

32. Bacillus tostus Blau. (Cent. f. Bakt., II Abt., 15, 1905, 130.) From

Latin tostus, parched, dried. Spores: Ellipsoidal, 08 to 1.6 by 1.5 to 22 microus. Germination prevail-

ingly polar.

Sporangia: Terminally swollen, clavate,

not in chains. Rods: 1 2 by 4.5 to 5.0 microns, occurring in pairs and in short chains. Cells storo glycogen. Motile with peritrichous

flagella Agar colonics: Small, circular, dense. By transmitted light bright yellow to yellowish-brown. Borders sharp, entire to lobate. Older colonies porcelain-like.

Agar slant : Growth thin, grayisb-white, spreading, smooth, glistening.

Potato . No growth.

Nitrites not produced from nitrates. Starch is hydrolyzed.

Ammonia is produced.

Thermophilic, optimum temperature 60°C to 70°C.

Aerobic.

:. :.

Source. Two cultures isolated from soil in Germany.

Habitat: Probably found in soil and dust.

33. Bacilius viridulus (Migula) Bergey et al. (Bacillus thermophilus II Rabinowitsch, Ztschr. f. Hyg , 20, 1895, 154; Bacterium viridulum Migula, Syst. der  1st ed., 1923, 315; Bergey et al., Manual. 4th ed., 1934, 464; not Bacillus thermophilus Miquel, Ann. d. Microg., 1, 1888. 6: not Bacillus thermophilus Chester. Man. Determ. Bact., 1901, 265.) From Latin, dim. adj. viridis, green, somewhat green.

Spores: Spherical, central

Sporangia: Cylindrical, not swollen

Rods: Rather large, slightly bent, occurring singly and in pairs. Nonmotile, Gram-positive.

Agar colonies: Irregular, spreading, granular, greenish.

Broth: Alkaline.

Potato: Growth grayish-yellow; margin undulate. Nitrites not produced from nitrates.

Starch is hydrolyzed.

Thermophilic, grows at 60°C to 70°C Optimum temperature 62°C. Grows st 33°C.

Aerobic, facultative.

Source: Isolated from soil, snow, feces, corn grains.

Habitat: Probably found in soil and dust.

Appendix: The following additional aerobic spore forming bacteria are found in the literature. Because of insufficient data it has not been possible to classify them. Some of these may be synonyms of well-known species, some may be varieties, whereas others may actually be separate species.

Aromabacellus wergmanne Omeliansky. (Isolated by Weigmann, 1890; Omeliansky, Jour. Bact., 8, 1923, 398) From

milk.

ыĮ,

Bacillus abysseus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., &, 1944, 273.) Subterminal

spores. From marine mud Bacillus acidifaciens Patrick and

Werkman (Iowa State Coll. Jour. Ser, 7, 1933, 413 ) One of a group characterized by the fermentation of xylan. A single culture isolated from decayed maple wood.

Bacillus acidificans presamigenes casei

Gorini. (Rend. R Acead. der Lincer. 8, 1928, 598 ) From manure, fodder and Regarded by Gorini (personal communication, 1925) as identical with Bacıllus circulans Jordan

Bacillus acido-proteolyticus cases Gorini (Le Last. 9, 1912, 98) Fram Parmesan and Emmenthal cheese garded by Goriai (personal communication, 1925) as equivalent to one of the species of Turathrix of Duclaux

Bacıllus adametzi Trevisan (Brauner Wasserbacillus, Adametz and Wichmann, Mittheil d. oesterr Versuchsstat f Brauerei u. Mälzerei, Wien, Heft I, 1888, 51; Trevisan, I genera e le specie delle Batterineee, 1889, 19; not Bacillus adametzii Migula, Syst. d. Bakt , 2, 1900, 686, Bacillus brunneus Eisenberg, Bakt Diag , 3 Aufl , 1891, 142, Bacterium brunneum Migula, thid , 331, not Bacterium brunneneum Schrocter, in Cohn, Beitr z Biol d Pflanz , 1, Heft 2, 1882, 125 ) From water

Bacillus adhaerens Laubach (Jour. Bact , 1, 1916, 503 ) One culture iso-

lated from dust

Bacillus aegyptiacus Werner (Cent f Bakt , II Abt., 87, 1933, 459 ) Good growth on Ca n-butyrate agar One culture isolated from Egyptian soil

Bacillus aerifaciens Steinhaus Bact , 42, 1911, 782 ) Author states that it probably belongs to the Aerobacellus group From triturated specimens of the white cabbace butterfly (Pieris rapae)

Bacillus aerobius von Wahl (Cent f. Bakt . II Abt . 16, 1906, 496 ) Reported to resemble Bacillus mesentericus fuscus From canned peas

Bacillus aerophilus Plugge. (Flügge, Die Mikroorganismen, 2 Auft, 1886, 321; Bacterium aerophilum Chester, Man Determ Bact , 1901, 191 ) From dust.

Bacillus afanassiefi Trevian cillus tussis conculsirae Afanassief, St Petersburg, med. Wochnschr , 1887, No. 38-42, not Bacillus tussis convulsitae Lehmann and Neumann, Bakt Ding, 4 Aufl , 2, 1907, 269; Trevisan, I genera e le specie delle Batteriacee, 1889, 13; Bacillus perlussis Migula, Syst d. Bakt . 2, 1900, 754.) From mucus and pus.

Bacillus Tschistowitsch. agilis (Tschistowitsch, Berl, klin, Wochnschr., 1892, 512; not Bacillus agilis Trevisan, I genera e le specie delle Batteriacee, 1889, 14; not Bacillus agilis Chester, Man Determ Bact , 1901, 226; not Bacillus agelis Mattes, Sitzungsber, d. Gesellsch. z. Beforderung d gesam Naturw. z. Marburg, 62, 1927, 406; not Bacillus agilis Hauduroy et al , Dict. d. Bact. Path . Paris, 1937, 33.) From pus.

Bacillus agilis Hauduroy et al. (Bacellus agilis lareae Toumanoff, Bull. Sec. Cent de Méd Vétér., 80, 1927, 367; Hauduroy, Ehringer, Urbain, Guillot and Magrou, Dictionnaire de Bactéries Pathogènes, Paris, 1937, 33 ) Found in

foulbrood of bees.

Bacillus agresiis Werner Bakt , II Abt., 87, 1933, 468; nat Bacillus agrestis de Rossi, Microbial, agraria e technica, Torino, 1027, 828.) One of a group of species described as being able to grow on a Ca n-butyrate agar Three cultures were isolated from German and Italian soils

Bacillus agri Laubach and Rice. (Jour Bact, 1, 1916, 516) Isolated twice from soil in Baltimare

Bacıllus agraphılus Stührk. (Cent f. Bakt , II Abt , 95, 1935, 189 ) Only moderate growth on Ca n-but vrate agar. One culture isolated from soil from Cuba. Bocillus agrotidis typhoides Pospelov.

(Rept Bur Appl. Ent., Russian, 5, 1927, 8) Found in diseased larvae of the moth, Euroa (Agrois) segetum.

Bacıllus (Streptobacter) albuminis Schroeter (Bacillus aus Faeces V. Bienstock, Ztschr f klin Med , 8, Heft 1, 1884, 1, Schraeter, in Colin, Kryptog. Flora v Schlesten, 3, 1, 1886, 162; Bacillus putrificus coli Flügge, Die Mikroorganismen, 2 Aufl , 1886, 303; Bacillus diaphthirus Treviann, I generi e le specie delle Batteriacce, 1889, 15.) From feces.

Bacillus albus (Sack) Bergey et al. (Cellulomonas albus Sack, Cent. f. Bakt , II Abt , 62, 1924, 79; Bergey et al., Manual, 3rd ed., 1930, 398; not Bacillus albus Trevisan, I generi e le specie delle Batteriacee, 1889, 14; not Bacillus albus Copeland, Report Filtration Comm., Pittsburgh, 1899, 314.) Cellulose is hydrolyzed. From soil in Germany.

Bacillus alcalophilus Vedder. (Ned. Tijdschr. v. Hyg. Microbiol. en Serolog., 1, 1934, 141.) Grows only in and on highly alkaline culture media. Sixteen strains isolated from the feces of healthy

nnimals.

Bacillus alopecuri Nogtev. (Botanicheskii Zhurnal, U.S. S.R., 25, 1938, 149.) Causes nodule formation on fox grass (Alopecurus pratensis).

Bacillus alpha Dyar. (Ann. N. Y. Acad. Sci., 8, 1895, 360.) Fron the air.
Bacillus alpinus Werner. (Cent. f. Bakt., II Abt., 87, 1933, 465.) Good growth on calcium salts of formic, nectic, propionic and butyric acids. One culture isolated from soil from Austria.

Bacillus alreolaris Ksenjoposky. (Review of pests of Volhymia, Volhymia Ent. Bur., Zemstvo of Volhymia, Zltomir, 1916, 24 pp.) From diseased bees (Apis mellifera).

Bacillus amarus Hammer. (Iowa Agr. Exp. Station Res. Bull. 52, 1919, 198.) From evaporated milk

Bacillus aminororans den Dooren de Jong. (Cent. f. Bakt., II Abt., 71, 1927,

215.) From soil.

Bacillus amyloaerobius Crimi (Abst. in Cent. f. Bakt., II Abt., 61, 1924, 63.) From potato rot.

Bacillus amylolyticus Kellerman and McBeth (Cent. f. Bakt., II Abt., 34, 1912, 490.) Decomposes cellulose. One culture isolated from manure.

Bacillus annulyformis Migula. (Fadenāhnlicher Bacillus, Maschek, Bakt. Untersuch d. Leitmeritzer Trinkwässer, Leitmeritz, 1887; Migula, Syst d. Bakt, 2, 1900, 783.) From water.

Bacillus anthracis similis McFarland. (Cent. f Bakt, 1 Abt., 24, 1898, 556)

From dust

Bacillus apicum Canestrini. (Atti Soc. Ven. Trent. Sci. Nat , 91; according to Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 233.) From diseased bees and their larvae.

Bacillus aporrhocus Fuller and Norman. (Jour. Bact , 46, 1913, 277.) From soil. Decomposes cellulose.

Bacillus arachnoideus Migula. (Bacillus No. III, Flügge, Zitschr. f. Hyg, 17, 1894, 294; Bacillus lactis No. III, Kruse, in Flügge, Die Mikroorganismen, 3 Aufl. 2, 1896, 208; Migula, Syst. d. Bakt., 2, 1900, 583; Bacterium lacteum Migula, 1bid., 321.) From milk.

Bacillus arenarius Stuhrk. (Cent i. Bakt., II Abt., 98, 1935, 187.) Good growth on Ca n-butyrate agar. One strain isolated from Cuban soil.

Bacillus aridus Migula. (Bacillus No. 8, Pansini, Arch. f. path. Anat, 122, 1800, 444; Migula, Syst. d. Bakt, 2, 1900, 559) From sputum.

Bacillus arlongii (sic) DeToni and Trevisan. (Bacillus de la septuêmie gangrêneuse, Arloing and Chauveau, see Crookshank, Man. of Bact., 3rd ed., 1830, 305; DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1839, 050.) From wounds in gangrenous septueaemia

Bacillus asiaticus Sakharoff (Sakharoff, Ann. Inst. Past., 8, 1893, 559; not Bacillus asiaticus Castellani, Cent. f. Bakt., I Abt., Orig., 65, 1912, 262.)

From feces in a case of cholera.

Bacillus asteris Verona. (Riv. Pat
Veg., 25, 1935, 15.) Pathogenic for
China aster (Aster chinensis).

Bacillus atthenogenes Bornard. (Ann. Inst. Past., 35, 1921, 459.) Grows eeroically as well as anaerobically. Under 
anaerobic conditions it is said to 
play a role in gastru derangement 
and infection commonly confused with 
beribert. Author reports that it is very 
similar to Bacillus megatherium.

Bacillus aterrimus ischilensis iülmenko. (Cent. f. Bakt., II Abt., 20, 1998, I.) Reported to be like the black potato bacillus except that it forms a black pigment on gelatin and the potato is brown instead of black. From air.

Bacillus aurantius (Sack) Bergey et al.

(Cellulomonas aurantius Sack, Cent f. Bakt., II Abt., 62, 1924, 78, Bergey et al., Manual, 3rd ed., 1930, 421; not Bacillus aurantius Trevisan, I generi e le specie delle Batteriacce. 1889, 19.) From soil

Bacillus badius Batchelor. (Jour. Bact, 4, 1919, 25) From the intestinal tract of children

tract of children

Bacillus balcanus Bartels. (Cent. f. Bakt., II Abt., 163, 1940, 25 ) Growth on media containing M/50 phenol Eight strains isolated from soil.

Bacillus barbitisles Statelov. (Alitt bulg ent Gesells ,7,1932,56-61) From diseased tettigonids (Isophya (Barbitisles) amplipennis).

Bacillus batatae Otani (Trans. Tottori Soc. Agric Sci , Japan, 6, 1939, 222)
From rotten sweet potatoes (Ipomaea batatas)

Bacillus bellus Hoigener (Cent f Bakt, II Abt, 93, 1935, 96) Probably a strain of Bacillus brevis. One culture isolated from garden soil of Germany

Bacillus bernensis Lehmann and Neumann (Aromabacillus, Burri, Cent f Bakt, II Abt, 3, 1897, 609, Lehmann and Neumann, Bakt Diag., 2 Aufl, 2, 1890, 301, Bacillus adoratis Migula, Syst. d Bakt, 2, 1900, 689, Bacterium adoratism Omeliansky, Jour. Bact, 8, 1923, 291) From Immenthal cheese Reported as producing the aroma of this cheese

Bacillus beta Dyar (Ann N Y Acad Sci, 8, 1895, 366) From dust

Bacillus belainatorans Heigener (Cent f Bakt, II Abt., 93, 1935, 94) Good growth on betaine and value agar One culture isolated from soil from Mantus.

Bacillus betanigrificans Cameron, Esty and Williams (Food Research, 1, 1936, 75.) From blackened canned beets where junce contains an abnormally high amount of iron.

Bacillus biaeutum Soriano (Revista del Inst Bacteriol., Univ. Buenos Aires, 6, 1935, 564.) From soil.

Bacillus bombyeis Macchiati (Des vibrious, Pasteur, Études sur la maladie des vers à soie, La Flacherie, Chapitre II. Paris, 1870; Macchiati, Staront spermentali Agrarie Italiane, 20, 1801, 121; not Baeillus bombycis Chatton, Compt rend. Acad Sci., Paris, 186, 1913, 1708; Baeillus megaterum bombycis Samanura, Tokyo Imp. Coll. Agric. Bull., 6, 19105, 375) Pasteur originally isolated this large bacillus from the intestine of sulkworns (Bombyz mort) suffering from wht disease. Regarded by Sawamura as a variety of Baeillus mocadherium

Bacillus bombycis non-liquefaciens Paillot. (Ann. Epiphyt., 8, 1922, 131, L'infection chez les insectes, 1933, 288.) Larvae of the gypsy moth (Lymantria dispar) are immune to this bacillus

Bacillus bombycoides Paillot. (Compt. rend Acad Agr. France, 28, 1942, 158.)
Causes lesions because of a bacterial toxin. From infected silkworms

Bacillus bombysepticus Hartman (Lingnan Sci Jour., 10, 1931, 280) Causes a disease of the silkworm (Bombyz mort)

Bacillus borborokoites ZoBell and Upham (Bull. Scripps Inst. of Oceanography, Univ Calif., 5, 1944, 274) Central spores From marino bottom deposits

Bacillus borstelensis Stührh. (Cent. f Bakt, II Abt, 25, 1935, 179.) Grows well on Can-butyrate agar. Resembles Bacillus rufescens of the same group except that it does not show the typical brown coloration of media. Two strains sealated from soils in Germany.

Bacillus bredemannı Chester (Bacillus adhaerens Stührk, Cent I Bakt., II Abt., 93, 1935, 183, not Bacillus adhaerens Laubach, Jour Bact., 1, 1916, 503, Chester, in Manual, 5th ed., 1939, 675) Weak growth on Can-butyrate agar One strain isolated from Cuban soil.

Bacillus bronchitelus Migula (Baellus der putridea Bronchitis, Lumnitzer, Cent f Bakt., 5, 1888, 621; Bacullus bronchitelus putridae Lumnitzer, Wien. med Presse, 1888, 603; Migula, 53, st. d. Bakt., 2, 1900, 611; Bacterium lumnitzeri Chester, Man Determ. Bact., 1901, 120) From sputum in cases of putrid bronchitis.

Bacillus bruneus Migula. (Masebek, Bakt. Untersuch. d. Leitmeritzer Trinkwasser, 1837; Migula, Syst. d. Bakt. 2, 1900, 835; not Bacillus brunneus Eisenberg, Bakt. Ding., 3 Aufl., 1891, 142.) From water.

Bacillus brunneus Eisenberg. (Bruuner Winsserbacillus, Adameta und Wichmann, Die Bakt. d. Nutz- u. Trinkwasser, Mitth. Oesterreich, Versuchssta, f. Brauerei u. Malserei, Wien, Heft 1, 1888, 51; Eisenberg, Bakt. Diag., 3 Aufl, 1891, 142; not Bacillus brunneus Schroeter, in Cohn, Kryptog, Flora v. Schlesien, 3, 1, 1886, 158; Bacterium brunneum Migula, Syst. d. Bakt., 2, 1900, 331.) From water. Noa-motile.

Bacillus bullerovii Serbinow. (Vēst. Russ. obšč. pčelovod. (Messager de la Soc. russo d'Apiculture), No. 3 nnd No. 11, 1912; see Rev. Appl. Entomol., Ser. A, 1, 1913, 94 and 441.) From black

brood of bees.

Bacillus butschlii Schaudinn. (Arch. f. Prolistenkunde, 1, 1902, 3003.) Characterized by its large size (3.0 to 6.0 by 24 0 to 80.0 microns) and granular protoplasm. From the intestine of a cockrach (Bitalia (Periplanela) orientalis).

roach (Blatta (Ferpaneta) orientais).

Bacillus butyricus Hucppe. (Hucppe. Mitteil. kaiserl Gesundheiteamte, 2, 1884, 309, not Bacillus butyricus Macé, 1871, 1892, 421; Clostridium hucpper Trevisan, 1 generi e le specie delle Batterincee, 1889, 22; Bacillus pseudobutyricus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 207, Bacillus hucpper Chester, Man. Determ Bact., 1901, 276.)

Bacillus calfactor Miebe. (Arh. der deutsch. Landw. Gesel., Berlin, Heft 3, 1905, 76; Die Selbsterhitzung des Heues, Jenn, 1907, 49.) Thought to be the most important thermogenic microorganism in the Iermentation of hay. From heating hay

Bacillus canaliculatus Wilhelmy.

(Arb. bakt. Inst. Karlsruhe, 3, 1903, 20) From meat extract.

Bacillus canceris Migula. (Syst. d. Bakt., 2, 1900, 625.) From a case of stomach cancer.

Bacillus caniperda Migula. (Ovalhacillus der Hundestaupe, Galli-Valero, Cent. f. Bakt., I Abt., 19, 1896, 691; Migula, Syst. d. Bakt., 2, 1909, 761; Bacterrum canis Chester, Man. Determ Bact., 1901, 193.) From nasal mucus and urine of dogs.

Bacillus capillaceus Wright. (Mem Nat. Acad. Sci., 7, 1895, 456.) From water.

Bacillus capsici Pavarino and Turconi.
(Atti Istit. Bot. R. Univ. Pavia, 15, 1918, 207.) Causes leaf wilt of pepper (Capsicum annuum). May be identical with disease caused by Pecudomona essicatoria (Stapp, in Soraner, Handbuch der Pflanzen-Krankheiten, 2, 5 Auf., 1928, 2023.)

Bacillus carniphilus Wilhelmy. (Arb bnkt. Inst. Karlsruhe, 5, 1903, 19)

From meat extract.

Bacillus carnosus Zimmermann. (Tils, Bakt. Untersuch. d. Freiburg. Leitungswässer, Leipzig, 1890, No. 57; Zimmermann, Bakt. unserer Trink. u. Nutzwasser, Chemnitz, II Reihe, 1894, 4.) From water.

Bacillus catenulatus Bartels. (Cent.i. Bakt., II Abt., 103, 1940, 27.) Growth on media containing 11/100 phenol. Four

strains isolated from soil.

Bacillus cepes Bassalik and Edelsztein-Kosowa. (Acta Soc. Bot. Polon, 10, 1933, 519.) From diseased onions (Al-

lium cepa).

Bacillus cercalium Gentner. (Cent.i. Bakt, II Abt., 6), 1920, 428; Picudomonas cercalia Stapp, in Somuer, Hawdburch der Pflanzen-Krankheiten, 5, 1923, 22; Bacterium erredium Eliott, Manuel Bacterial Plant Pathogens, 1930, 111.) Pathogenie for barley (Hordeum vulgare), 179 (Secale cercale) and wheat (Triticum 3p.).

Bacillus cinctus Ravenel. (Mem. Nat. Acad. Sci., 8, 1896, 30.) From soil.

Bacillus cirrofiagellosus ZoBell and Upham (Bull Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 266) Central stores. Found in marine mud

Bacillus cladoi Trevsan (Bacille pedunculé, Clado, Bull. Soc Annt. Paris, 1837, 339; Trevisan, I generi e le specie delle Batternacee, 1839, 14; Bacillus pendunculatus (sic) Eisenberg, Bakt Ding, 3 Aufl, 1801,340; Bacillus septieus esseca Sternberg, Man. of Bact, 1833, 4475) From uring in a case of cyattus.

Bacillus closteroides Gray and Thornton (Cent. f Bakt., II Abt., 73, 1923, 93) Decomposes phenol. Probably identical with or a variety of Bacillus circulans. Sitteen strains isolated from Rothamsted soils

Bacillus coccineus Pansini (Pansini, Arch f path Anat , 122, 1890, 437, not Bacillus coccineus Catiano, in Cohn, Boitr z Biol. d Pflanzen, 7, 1896, 339 ) From sputum. Red pigment

Bacilius colorans Libermann. (Jour of Microbiol , Ukraine, δ, 1938, 73, abst in Cent f. Bakt , II Abt , 101, 1940, 81) From fruit conserves containing 10 to 20 per cent sugar.

Bacillus comesii Rossi (Ann d Scuola d Agricult in Portici, 1903, Arch di Farmacologia sperim, 5, 1901, fasc 10) Similar to Bacillus mesentericus Said to have the ability to dissolve plant particles

Bacillus concoctans Patrick and Werkman (Iowa State Coll Jour Sci, 7, 1933, 415) Ferments xylan One culture isolated from soil.

Bacillus conjunctivitidis subtitiformis Michalski (Cent. f Bakt, I Abt, Orig, 56, 1904, 212) From more than 50 cases of acute conjunctivitis Similar to Bacillus subtitis

Bactilus consolidus Stührk (Cent. f Bakt, II Abt, 93, 1935, 191) Good growth on Ca n-butyrate agar. One strain isolated from Cuban soil.

Bacillus contextus Migula (Bacillus D, Peters, Botan Zeitung, 47, 1889, Migula, Syst. d Bakt, 2, 1900, 522) From leaven.

Bacillus corrugatus Migula. (Bacillus mesentericus vulgatus Flugge, Die Mikroorganismen, 2 Aufl , 1886, 322; Bacillus No. II, Flügge, Ztschr. f. Hyg, 17, 1894, 294, Bacillus Lacisi No. II, Kruse, in Flügge, Die Mikroorganismen, 3 Aufl, 2, 1896, 203; Migula, Syst. d. Bakt., 2, 1900, 683.) From milk.

Bacillus corruscans Schroeter. (In Cohn, Kryptog Flora v. Schlesien, 3, 1, ISS6, 158) From cooked potato.

Bacillus costatus Lloyd (Jour. Bact, 21, 1931, 94.) From sea water off Scotland. Nitrates and nitrites reduced to nitrogen.

Bacillus crinatus Chester. (Bacillus No. 5, Pansim, Arch f. path. Anat., 122, 1890, 441; Chester, Man. Determ Bact, 1901, 281.) From sputum.

Bacillus crinitus Wright. (Wright, Mem. Nat Acad. Sci, 7, 1895, 453; Bacterium crinatum (sic) Chester, Man. Determ Bact., 1901, 192.) From river water.

Bacillus crystalloides Dyar. (Dyar, Ann N. Y. Acad Sci., 8, 1895, 371; Bacterium crystaloides (sic) Cheeter, Man. Determ. Bact., 1901, 191.) From the air.

Bacillus cubensis Stuhrk. (Cent. f. Bakt., II Abt., 93, 1935, 192.) Good growth on Ca n-butyrate agar. Two cultures isolated from soils from Cuba.

Bacillus cystiformis Trevisan (Bacille cystiforme, Clado, Bull. Soc. Anat. Paris, 1887, 339; Trevisan, I generi e le specie delle Batteriacee, 1889,14) From urine in a case of cystitis

Bacillus cylassus McBeth and Scales (U S Dept Agr., Bur. Plant Industry, Bull. 269, 1913, 39; Bacterium cylasterium Golland, Jour Bact., δ, 1929, 218.) Requires celluloss for best growth From decomposing materials and soil.

Bacillus cytaveus var. zonalis Kellerman et al (Cent f Bakt., II Abt., 39, 1913,511) From soil from Utah While no spores were observed, this organism was like Bacillus cytaseus evcept that colonies on cellulose agar showed consentric opaque or semi-opaque and transparent zones.

Bacillus danteci Kruse. (Bacillo rouge de Terre-Neuve, Lo Dantec, Ann. Inst. Past., 5, 1891, 662; Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 270.) From reddened salt cod fish.

Bacillus daucarum von Wahl. (Cent. f. Bakt., II Abt., 18, 1906, 494.) Apparently a strain of Bacillus subtilis. From

canned carrots.

Bacillus demmei Trevisan. (Bacillus der Erythema nodosum, Demme, Fortschr. d. Med., 6, 1889, 257; Trevisan, I generi e le specie delle Batteriacce, 1889, 14; Bacillus erythematis Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 420; Bacillus erythematis migni Kruse, titid, 479; Bacterum erythematis Migula, Syst. d. Bakt., 2, 1990, 346.) From erythema nodosum (skm).

Bacillus dendroides Holzmüller. (Cent. f Bakt., II Abt., 23, 1909, 331.) From frog feces. Closely related to

Bacıllus mycoides.

Bacillus dendroides Thornton. (Thornton, Ann. Appl Biol., 9, 1922, 247; not Bacillus dendroides Holzmüller, loc. ett.) Common in Rothamsted soil. Said to belong to the Bacillus subtilis group.

Bacillus dentatus Heigener. (Cent. f. Bakt., II Abt., 23, 1935, 196) Good growth on valine agar Two cultures isolated from soil of Jugoslavia and North

Carolina.

Bacillus destruens von Wahl. (Cent. f. Bakt., II Abt., 16, 1906, 502) From boiled asparagus.

Bacillus detrudens Wright. (Mem. Nat. Acad. Sci., 7, 1895, 452) From water.

Bacillus diastaticus Boyarska (Izvestia Acad Sci., U.S.S.R., Biol Scr., 1941.) Thermophilic.

Bacillus disciformans Zunmermann. (Zimmermann, Bakt. unserer Trink. u. Nutzwässer, Chemnutz, II Reihe, 1891, 48; Bacterium disciformans Lehmann and Neumann, Bakt Dag., 1 Aufl., 2, 1896, 233) From waste water. Apparently not identical with Bacillus disciformis Grafenhan, although the name suggests possible relationship.

Bacillus disciformis Gräfenhan. (Leaug. Diss., Halle, 1891, 1.) From nater. From the description, this organism may be Bacillus subtilis.

Bacillus distorius (Duclaux) Trevisan. (Tyrothriz distorius Duclaux, Ann. Inst. Nat. Agron., 4, 1882, 23; Trevisan, I generi e le specie delle Batteriacee, 1889, 16.) From milk.

Bacillus dobelli Duboscq and Grasse (Arch. Zool. Exper. et Gén., 65, 122, 487; Bacillus (Fiezilis) doelli Duboscq and Grasse, ibid., 487.) Similar to Bacillus facilitis Dobell. Found in rectum of a termite (Caloternes (Glyptoternes) iridipennes). These authors suggest that Bacillus fiezilis Dobell, Bacillus batechii Schaudinn and Bacillus obstechii Schaudinn and Bacillus obstechii Schaudinn and Bacillus be grounded under the name Flezilis

Bacillus duclauzii (Miquel) Chester (Bacillus urcae Miquel, Bull. Soc. Chim d Paris, 81, 1879, 391; Urobacillus duc clauzii sive Bacillus urcae s Miquel, Ann. d. Microg., 2, 1889-1890, 53, 122 and 145; Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 10, 1898, 123.) From

water and soil.

Bacillus dysodes Zopf. (Die Spaltpilze, 3 Aufi., 1885, 90.) From fermenting dough.

Bacillus elegans Heigener. (Cent. I. Bakt., II Abt., 93, 1935, 103.) Four cultures isolated from soil, one from Jugoslavia and three from Germany.

Bacillus enulsionis Beijerinck. (Folia Microbiol., 1, 1912, 377; see Perquin, Jour. Microbiol. and Serol., 6, 1940, 226) Produces slime in sucrose solutions

Hacillus encephaloides Trevisan. (Bacille de l'air f, Babes, in Cornil and Babes, Les Bactéries, 1886, 150; Trevisan, I generi e le specie delle Batteriaces, 1880, 20.) From the air.

Bacillus enterothriz Collin. (Arch. Zool. Expér. et Gén., 81, 1913, Notes and Revue, No. 3.) Found in the rectum of toad hadpoles (Alytes sp.).

Bacillus epidermidis (Bizzozero) Bordoni-Ultreduzzi. (Leptothrix epidermi-

dis Bizzozero, Arch. f path Anat, 98, 1884, 441: Bordoni Uffreduzzi, Fortschr. d Med., 4, 1886, 156; Carcinombacillus, Scheurlen, Deutsche med. Wochnschr. 1887, 1083, Bacillus mesentericus rubiosnosus Senger, Cent f. Bakt , 3, 1888, 603; Bacıllus bizzozerianus Trevisan, I generi e le specie delle Batteriacec, 1889, 14, Bacillus scheurlens Dyar, Ann N Y Acad Sci. 8, 1895, 367) From the human mouth and skin Macé (Traité pratique de Bact . 4th ed . 1901. 1071) says that this organism is the ordinary potato bacillus, i e . Bacillus rulgatus

Bocillus epiphytus ZoBell and Upham (Bull. Scripps Inst. of Oceanography, Univ Calif, 5, 1944, 266) Central spores Found associated with marine

phytoplankton

Bacillus erodens Ravenel. (Meni Nat Acad Sci , 8, 1896, 35 ) From soil. Bocillus esterificans Maasson

a d karserl Gesundhertsamte, 15, 1899, 504, Pleetridium exterificans Huss, Cent f Bakt, II Abt, 19, 1907, 52) Found in a solution of decomposing litmus; also isolated from hutter.

Bacillus esanidus Grohmann Morphologisch biologische Beiträge Kenntnis der Wasserstoffbakterien, In-

aug Diss, Univ Leipzig, 1923, Cent f Bakt , II Abt., 61, 1924, 207, Rubland and Grohmann, Jahrb Wissensch Botanik, 65, 1924, 321 ) Oxidizes hydrogen in the presence of oxygen to form water Presumably widely distributed in soil

Bacillus exiguus Saito (Jour Coll Sci , Imp Univ , Tokyo, 25, Art 15, 1908, 44 ) Isolated 3 times from garden air

Bacıllus exilis Bartels (Cent Bakt , If Abt , 105, 1940, 29 ) Growth in media containing M/100 phenol Eight strains isolated from soil

Bacillus fastidiosus den Dooren de Jong. (Cent. f. Bakt , 11 Abt., 79, 1929, 344 ) Six strains isolated from unheated garden soil.

Bacıllus ferrigenus Bargagho-Petrucci (Nuovo Giornale botanico italiano, 1913, 1914, 1915; quoted from De Rossi,

Microhiol. Agraria e Technica, 1927, 904.) A facultative thermophile, growing up to 65° to 70°C

Bacıllus festinus McBeth. (Soil Sci , 1, 1916, 451.) Filter paper decomposed to a grayish-white felt-like mass From soil in California.

Bacillus filamentosus Klein see Migula, Syst. d Bakt., 2, 1900, 285; Baclerium filamentosum Burchard, Arb. bakt Inst. Karlsruhe, 2, Heft 1, 1902, 22.) Bacillus filaris Migula (Bacillus No. XI, Flügge, Ztschr. f Hyg , 17, 1894, 296, Bacillus lactis No. XI, Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 209, Migula, Syst. d. Bakt., 2, 1900, 579; Bacillus aromaticus Chester, Man. Determ. Bact., 1901, 276; not Bacillus aromaticus Pammell, Bull. No. 21, Iowa Agr. Exp Sta , 1803, 792; not Bacillus aromaticus Grimm, Cent f. Bakt., II Abt , 8, 1902, 584 ) From milk.

Bacillus filicolonicus ZoBell and Up-(Bull Seripps Inst. of Occanography, Univ Calif , 5, 1944, 270.) Subterminal spores. From sea water and marine mud

Bacillus filiformis (Duclaux) Trevisan. (Tyrothrix filiformis Duclaux, Ann. Inst. Nat Agron, 4, 1882, 23; Trevisan, I generi e le specie delle Batteriacec, 1889, 16, not Bacellus fileformes Tels. Ztschr. f. Hyg., 9, 1890, 317, not Bacillus filiformis Migula, Syst d Bakt , 2, 1900, 587.) From cheese

Bacillus fissuratus Itavenel. Alem. Nat. Acad Sci , 8, 1896, 38 ) From soil. Bocillus fitzianus Zopf (Fitz, Ber. d.

deutsch chem Gesellsch, 6, 1873, 48; ibid , 9, 1876, 1348, ibid , 10, 1877, 276, Glycermaethylbacteric, Buchner, in Nagelz, Untersuch G niedere Pilze, 1882. 220, Zopf, Die Spaltpilze, 1 Aufl., 1883, 52; Bacterium fitzianum Zopf, Die Spaltpilze, 2 Aufl, 1884, 49) From boiled hav

infusions. Forms but vric acid.

Bacillus flagellifer Migula. (Bacillus No VI, Flügge, Ztschr. f. 113g , 17, 1894, 291; Bacillus lactis No VI, Kruse, in Flugge, Die Mikroorganismen, 3 Aufl , 2, 1896, 209; Migula, Syst. d. Bakt.,

2, 1900, 581; Bacillus rudis Chester, Man. Determ. Bact., 1901, 279.) From milk.

Bacillus flarescens Weiss. (Weiss, Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 255; not Bacillus flarescens Pohl, Cent. f. Bakt., 11, 1892, 144.) From brewer's grains. Uncommon.

Bacillus flavidus Stührk. (Cent. f. Bakt., II Abt., 28, 1935, 185; not Bacillus flavidus Fawcett, Rev. Indust. y Agrico. de Tucuman, 18, 1922, 5; not Bacillus flavidus Mosse, Jour. Inf. Dis., 11, 1912, 284.) Good growth on Ca. n-butyrate agar. One culture isolated from soil from Egypt.

Bacillus flavidus alrei Klamann. (Bienenwirtschaftl. Cent., Hanover, 1890, No. 2.) Associated with foulbrood of bees.

Bacillus flavoriridis Migula. (Maschek, Bakt. Untersuch. d. Leitmeritzer Trinkwässer, Leitmeritz, 1887; Migula, Syst. d. Bakt, 2, 1900, 821.) From water.

Bacillus fierilis Dobell. (Quart. Jour. Mores Sci. 52, 1903, 121; Arch. f Protistenk., 26, 1912, 117.) Reported as being similar to Bacillus bütschlif Schaudinn although only half its size. From the large intestine of frogs (Rana temporaria) and toads (Bufo vulgaris)

Bactlus flexus Batchelor. (Jour. Bact., 4, 1919, 23.) Resembles Bacillus megalherium. From intestinal contents of a child.

Bacillus fluorescens undulatus Ravenel. (Mem. Nat Acad Sci, 8, 1896, 20.) From soil

Bacillus folaccus Migula (Bacillus mesentericus fuecus Flugge, Die Mikroorganismen, 2 Aufl, 1886, 321; Bacillus No IV, Flugge, Zischr. f Hyg., 17, 1894, 294; Bacillus lacts No. IV, Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 208, Migula, Syst d. Bakt., 2, 1990, 582) From milk, aur and soil.

Bacillus formosus Heigener. (Cent. f. Bakt, JI Abt., #3, 1935, 101, not Bacillus formosus Ravenel, Mem Nat. Acad. Sci., &, 1896, 12.) One culture isolated from soil from Montenegro. Bacillus foutini Chester. (Bacillus D, Foutin, Cent. f. Bakt., 7, 1890, 373; Chester, Man. Determ. Bact., 1901, 285.) From hail.

Bacillus frankei (sic) DeToni and Trevisan. (Sarkombacillen, Franke, Münch. med. Wochnschr., 1883, No. 4; abst. in Cent. f. Bakt., 8, 1888, 601, DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 067.) Fromease of sarcoma.

Bacillus freudenreichii (Miquel) Chester. (Urobacillus freudenreichii sive Bacillus ureae y Miquel, Ann. d. Mirographie, 2, 1890, 367 and 488; Chester, Ann. Rept Del. Col. Agr. Evp Sts. 10, 1898, 110.) Lohais (Cent. f. Bakt., 11 Abt., 14, 1905, 710) considered this a variety of Bacillus pumilus. Gibbon (Jour. Bact., 29, 1935, 493) believed it belonged to the Bacillus pasteurii group although no authentic cultures were available. From soil.

Bacillus frutodestruens Madhok sud Ud-Din. (Indian Jour. Agr. Sci., 18, 1913, 129.) Causes a rot of tomato fruit

Bacillus funicularis Kluyver and Yan Niel. (Planta, Arch. f. wissensch. Botsnik, 2, 1926, 507.) Exhibits contact irritability. From soil.

Bacillus furrus Gondby (Deatsl Cosmos, 42, 1900, 322.) From the mouth. Associated with dental caries.

Bacillus (Streptobacier) fusisporus Schroeter. (In Cohn, Krypt. Flora v Schlesien, 3, 1, 1886, 181.) From waste water in a sugar factory.

Bacillus fusus Batchelor. (Jour. Bact., 4, 1919, 27.) Said to resemble Bacillus centrosporus, i e., Bacillus brens. From feces.

Bacillus gangliformis Ravenel. (Ravenel, Mem. Nat. Acad. Sci., 8, 1896, 34;
Bacterium gangliforme Chester, Man
Determ. Bact., 1901, 193.) From soil.

Bacillus gangraenae Chester. (Bacilus gangraenae pulpae Arkövy, Cent. 1 Bakt., 25, 1897, 921; Chester, Man-Determ. Bact., 1991, 275; not Bacillus gangraenae Tilanus, Nederl. Tijdschr. v. Geneeskunde, 21, 1885, 110) Associated with gangrene of tooth pulp and caries of teeth.

Bacillus gasoformans Panmel. (Pammel, Cent. f Bakt., II Abt., 2, 1896, 612; not Bacillus gasoformans Lisenberg, Bakt. Ding., 3 Aufl., 1891, 107; Bacillus pammelis Chester, Man. Determ Bact, 1901, 270.) From cheese.

Bacillus gelatinasus Migula (Bacterium gelatinasum betae Gliaser, Cent f. Bakt, II Abt, f, 1935, 879, Migula, Syst. d Bakt, 2, 1900, 805) Produces slime in sucrose solutions Probably a variety of Bacillus vulgatus according to Sacchetti (Cent. f. Bakt, II Abt., 36, 1036, 118)

Bacillus geniculatus (Duclaux) Trevisan. (Tyrothru geniculatus Duclaux,
Ann. Inst. Nat. Agron., 4, 1882, 23;
Trevinan, I genet le la pacele delle Battoriacce, 1880, 16; not Bacullus geniculatus De Bary, Inaug Diss., Strasburg,
Leipsig, 1885; not Bacullus geniculatus
Wright, Mem. Nat. Acad. Sci., 7, 1894,
489; Bacillus genitodes DeToni and
Trovisan, in Saccardo, Sylloge Fungotum,
8, 1889, 094; Bacierum geniculatum
Migula, Syst. d. Bakt., 2, 1000, 322.)
From mills.

Bacillus gigas (Koch) Trevisan.

gigat Koch, in Cohn, Beitr. z. Biol. d. Planz, z. Het 3, 1874, 292, Metallacter gigas Trevisan, Batter stal., 1879, 25; Trevisan, Atti. d. Acead. Fra Med-Stat, Milan, Ser. 4, 5, 1886, 96, not Bacillis gigas van der Goot, Med. Troefstation voor de Java Sutkerindust, pt. 5, No. 10, 1915, 281, not Bacillis gigas Zesisfer and Rassefeld, Arch. f. wiss u prakt. Tierheilk., 69, 1929, 419.) From percardial evudate

Bacillus ginglymus Ravenel. (Mem Nat Acad Sci ,8, 1896, 37) From soil. Bacillus glaciformis Wilhelmy. (Arb bakt Inst Karlsruhe, 5, 1903, 29) From meat extract. Bactlus globifer Bartels. (Cent f. Bakt, II Abt, 103, 1940, 26.) Growth on media containing x/100 phenol. Author considers it similar to Bactlus glest. Five strains isolated from soil

Bacillus glutinis Patrick and Werkman. (Iowa State Coll. Jour. Sci., 7, 1933, 414) Ferments xylan. Two

strains isolated from decayed apple wood.

Bacillus glycinophilus Rippel. (Rippel Arch f Milmelya) 2 1027 10

on agar form protein from glycine and glucose.

Bacillus gossypina Stedman. (Alabama Agr Exp Sta Bul. 55, 1894, 6; Earle, Alabama Agr Exp. Sta Bul. 107, 1899, 311) Reported as cause of boil ret on cotton (Gossypium sp.)

Bacillus granularis Stührk (Cent. f. Bakt., II Abt., 93, 1935, 190) Very good growth on Can-butyrate agar. One culture isolated from garden soil in Germany.

Bacillus granulosus Russell (Russell, Zischt f Hyg, fil, 1892, 194, Bacterum granulosum Chester, Man Determ Bact, 1901, 194) From mud from the Gulf of Naples.

Bacillus grossus Migula (Bacterienart No. 13, Lembke, Arch f. Hyg , 26, 1896, 303, Migula, Syst d. Bakt., 2, 1900, 570.) From the intestines of infants.

Bacillus gryllotalpae Metalnikov and

II Abt, 51, 1920, 29) From soil previously fertilized with guano

Bacillas gamnosus Happ. (Bakt. und Chem Untersuch über die schleimige Gahrung Univ. Basel, 1893, 31, abst in Cent. I Bakt, 14, 1893, 175) From digitales indruonas. Presumably a mucoid form of a common spore-former Son Bacteria

Rpt.

1911, 69.) Pathogenic for willow (Saliz sp.).

Bacillus hessii (Guillebeau) Kruse. (Bacterium hessii Guillebeau, Landw. Jahrb. d. Schweiz, 6, 1821, 132; Kruse, in Flugge, Die Mikroorganismen, 3 Aufl. 2, 1896, 210.) There is some question whether the original culture was a spore-former or whether it was mixed with one of the common slimy milk organisms From slimy milk.

Bacillus hirudinus Schweizer. (Arch. f. Mikrobiol., 7, 1936, 235) From the digestive slime of leeches (Hirudo medicinalis and Hirudo officinalis).

Bacillus hollandicus Stapp. (Cent. f. Bakt., II Abt., 51, 1920, 47.) From soil

from Delft.

Bacillus hoplosternus Paillot. (Compt. rend. Acad. Sci., Patis, 163, 1916, 774; Ann. Inst. Past., 33, 1919, 403.) Isolated once from the body fluid of a June bug. Pathogonic for several species of insects.

Bacillus imminutus McBetb. (Soil Sci., 1, 1916, 455.) Growth only in the presence of cellulose. From ten different

sails of California.

Bacillus immebilis Steinhaus. (Jour. Bact., 42, 1941, 783.) The author states that it probably belongs to the Bacillus adhaerne group. From rectum of larvae of the sphinx moth (Ceratomia catalpae).

Bacillus imomarinus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif, 5, 1944, 205.) Subterminal spores. From marine bottom denosits in shoal waters

Bacillus indifferens Soriano. (Thesis, Univ. Buenos Aires, 1935, 565.) One

strain isolated from soil

Bacillus infantilis Kendall (Jour Biol. Chem, 6, 1909, 419 and 439) From the intestine in cases of infantilism. Saprophytic.

Bacillus intermittens Wilhelmy (Arb. bakt. Inst Karlsruhe, 3, 1903, 23)

From meat extract

Bacillus intrapallans Forbes (Bull. Illinois State Lab Natur Hist, Art IV, 1886, 283, 288 and 297) Bacillus jubatus Bartels. (Cent. I. Bakt., II Abt., 103, 1940, 24.) Veg good growth on media containing wi3 phenol. Nine strains isolated from sol. Bacillus kaleidoscopicus Wilhelmy. (Arb. bakt. Inst. Karlsruh, 5, 1963, 31.)

From meat extract.

Bacullus kefir Kuntze. (Cent. f
Bakt., II Abt., 24, 1909, 116.) From
kefir, a Caucasian milk beverage

Bacillus kermesinus Migula. (Karminroter Bacillus, Tatsroff, Inaug Diss, Dorpat, 1891, 67; Migula, Syst. d. Bakt, 2, 1900, 858.) From water.

Bacillus kildini Issatchenko. (Recherches sur les Microbes de l'Octan Glacial Arctique. Petrograd, 1914)

From sea water.

Bacillus koubassoffii Chester. (Bachus der krobsartigen Ncubildungen, Koubassoff, Vortrag Moskauer Mütarürztlichen Verein, 1888, No. 22; abt in Cent. f. Bakt., 7, 1890, 317; Chester, Man. Determ. Bact., 1901, 222 From

the stomachs and intestines of birds.

Bacillus lactis-albus Chester. (Bacillus lactis albus Sternberg, Man of Bact, 1893, 680; Chester, Man. Determ. Bact, 1901, 277.) From milk.

Bacillus lactucae Voglino. (Ann. R. Accad. Agr. Torino, 48, 1903, 25.) Pathogenic for lettuce (Lactuca satina).

Bacillus lasiocampa Brown. (Amer. Museum Novitates, No. 251, 1927, 7) Said to belong to Bacillus subtilis group From ovaries and egg tubes of tent caternillar moth

Bacillus latrianus Kalnins. (Latvijas Univ. Raksti, Serya I, No. 11, 1930, 205) Cellulose attacked at 34°C but not st 37°C. Probably from soil.

Bacillus lautus Batchelor. (Jour. Bact., 4, 1919, 30 ) One culture from

Bacillus legrosii Hauduroy et al. (Legros, Thèse Méd Paris, 1902; Hauduroy et al., Diet d Bact. Path., 1937, 43) Facultative anaerobe producing gascous gangrene. From a gascous suppuration

Baailus leguminiperdus von Oven. (Cent. f. Bakt, II Aht., 16, 1905, 67; Bacterium leguminiperdum Stevens, The Fungi which Cause Plant Disease, 1913, 28) Pathogenic for lupine (Lupinus sp.), kidney bean (Phaseolus sulgaris), pea. (Pisum satirum), tomato (Lycopersicum esculentum).

Bacillus lehmanni Herter. (Mierobe 5A, Choukéviteh, Ann. Inst. Past., 25, 1911, 350, Herter, Just's Botan. Jahresber, 59, 2 Abt., Heft 4, 1915, 748) From the large intestine of the horse

Bacillus lektoris Perlman. (N. Y. State Dept. Agr. and Markets, Ann Rept., 1981, 115.) Egg lecithin hydrolyzed completely by powerful extracellular enzyme. From contaminated sample of whole mixed eggs.

Banillus lerages Trevisan (Bacille de la diarrhée verte des entants, Lesage, Bull Acad, Méd Paris, Oct. 25, 1887, Trevisan, I generi e le specie delle Batteriacee, 1889, 14.) From the intestine of infants.

Baailus letaniformans Greig Smith. (Proc Linn Soc. New South Wales, 26, 1901, 589, 674 and 684; Cent f. Bakt., 11 Abt. 8, 1902, 2083) Produces slime is sucrose solutions. Probably a variety of Bacillus vulgatus according to Sacebetts (Cent f. Bakt. 11 Abt. 25, 1936, 115)

Bacillus licheriformis (Weigman) Chester. (Bactrie a, Weigmann, Cent. f Bakt., II Abt. 2, 1896, 155; Clostridum licheniform Weigmann, Det. ct., 4, 1888, 822, Chester, Man. Determ Bact., 1901, 287; see also Gibson, Soe Agre Bact. (liritish), Abstr Proc., 1927, Paper No. 10, Gibson and Topping, thd., 1938, 43; Gibson places this with Bacillus subtilis although it was originally described as leng Graming atternation of the company of the company. Spore germantion polar angua, Spore germantion polar

Bacillus lichenoides Grohmann. (Morphologisch-biologische Beiträge zur Kenntnis der Wasserstoffbakterien, Inaug Diss, Univ. Leipzig, 1923, Cent f Bakt., HAbt, 61, 1924, 267; Ruhland and Grohmann, Jahrb. wissensch Botanik, 63, 1921, 321.) Oxidizes hydrogen in the presence of oxygen to form water Presumably widely distributed in soil.

Bacillus lignivorans Patrick and Werkman (Iowa State Coll. Jour. Sci., 7, 1933, 410) Ferments xylan One culture isolated from decayed maple wood.

Bacillus Ingnorum Patrick and Werkman. (Iowa State Coll. Jour. Sci., 7, 1933, 410) Ferments xylan One culture isolated from decayed apple wood.

Bacillus limnophilus Stuhrk. (Cent. f Batt., II Abt., 93, 1935, 190) Good growth on Ca n-butyrate agar. One culture isolated from soil of Germany.

Bacillus lingural Trevisan. (Bacillus de la stomatite ulcereuse du veau, Lingard and Batt; Trevisan, I generi e le specie delle Batteriacce, 1889, 14) From ulcerations on the longue and mucous membrane of the mouth of calves

Bacillus lividus Zimmermann. (Bakt. unserer Trink- u. Nutzwässer, Chemnits, II Reihe, 1804, 18; not Bacillus lividus Voges, Cent f Bakt, 14, 1893, 303.) From water.

Bacillus longior Saito. (Jour. Coll Sea., Imp. Univ , Tokyo, 23, Art. 15, 1908, 57.) Isolated once from garden air.

Bacillus longus Migula. (Bacillus No VII, Flugge, Ztschr f Hyg, 17, 1891, 296, Bacillus lactis No. VII, Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 209; Migula, Syst. d. Bakt., 2, 1900, 581; not Bacillus longus Chester, Man. Determ Bact , 1901, 303; Bacillus plicatus Chester, ibid , 275, not Bacillus plicatus Frankland and Frankland. Philos Trans. Boyal Soc London, 178, B, 1887, 273; not Bacillus plicatus Zimmermann, Bakt unserer Trink- u. Nutzufisser, Chemnitz, I Reihe, 1890, 54; not Bacillus plicatus Deetjen, Inaug. Diss , Würzburg, 1890; not Bacillus plicolus Copeland, Rept. Filtration Commission, Pittsburgh, 1899, 348.) From milk.

tions only a weak reduction. From garden soil.

Bacillus nobilis Adametz. (See Freudenreich, Cent. f. Bakt., II Abt., 7, 1901, 857; ibid., 8, 1902, 674.) This organism was sold under the name Tyrogen; it was said to play a part in the ripening of hard cheese. This was doubted by Freudenreich who identified if as one of the Tyrothriz group Original description apparently in Osterreichen Mokereizcitung, Nov. 18, 1900; Dec. I and 15, 1900; Milehzeitung, Nov. 48, 1900.

Bacillus novus (Huss) Bergey et al. (Picetridium novum Huss, Cent. f. Bakt., II Abt., 19, 1907, 256; Bergey et al., Manual, 1st ed., 1923, 301.) From sterilized milk.

Bacillus oblongus Eckstein. (Ztschr. f. Forst. u. Jagdwesen, 26, 1891, 16.) From the larvae of a moth (Hyponomeula evonymella).

Bacillus oekensis Bartels. (Cent. f. Bakt, II Abt., 103, 1949, 28.) Growthon media containing w/100 phenol. Ono

culture isolated from soil. Cent. Bacillus oleae Schist-Giorgini. (Cent. f. Bakt, II Abt., 15, 1905, 203.) Thought to be the cause of tubercles on the olive

tree from which it was isolated.

Bacillus omchanskii Serbinoff. (Zhurnal Bolezni Rastenii, Leningrad, 9, 1915, 105.) Causes a rot of sorghum.

Bacillus outarion: (Chorine) Stemhaus (Bacierum ontarion: Chorine, Internat. Corn Borer Invest., Sci Bpts., 2, 1929, 44, also Ann. Inst. Past., 43, 1929, 1658, B outariom: Paillot, B presumably indicates Bacterium, see index, p. 522, L'intection chez les insectes, 1933, 134; Steinhaus, Bacteria Associated Extracellularly with Insects, Minneapolis, 1942, 72) From diseased larvae of the corn borer (Pyraustra nubilalis Hb.).

Bacillus oogenes Migula. (Bacillus oogenes hydrosulfureus a, Zörkendorfer, Arch ( Hfg., 16, 1833, 385; Migula, Syst. d. Bakt., 2, 1900, 573.) From hens' eggs. Bacillus opacus Weiss (Arb bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 244.) From bean infusions and fermenting cabbage.

Bacillus orae Werner. (Cent. f. Bakt, II Abt., 37, 1933, 464.) Weak growth on agar containing calcium salts of formic, acetic, and butyric neids. One culture isolated from European soil.

Bacillus oxylacticus Dyar. (Dyar, An. N. Y. Acad Sci., 8, 1895, 369; Bacterium oxylacticus Chester, Ann. Rept Del. Col. Agr. Exp. Sta., 9, 1897, 107.) From air and a culture from Krill: aboratory labeled Bacillus oxylacticus. The latter is given in the Krill 1900 catalogue as Bacillus oxolaticus Xopi and undoubtedily was the organism received by Migula from Zopf and studied by him Gligula, Arb. tech. Hochschule Krilsruhe, f., Heft I, 1894, 139 and Migula, Syst. d. Bakt., 2, 1900, 533) This is now regarded as having been Bacillus megatherium De Barry.

Bacillus pabuli Schieblich. (Cent. I Bakt., Il Abt., 58, 1923, 204.) Commonly isolated from green and ferment-

ing fodder.

Bacillus pellidus Heigener. (Cent. f. Bakt., II Abt., 93, 1935, 98.) One strain isolated from soil from New York State.

Bacullus palustris Sickles and Shan-(Jour. Bact., 28, 1931, 418; Rhodobanllus palustris Sickles and Shaw, Jour. Bact., 58, 1939, 241.) Decomposes the specific carbohydrate of pneumococcus type III

From swamp and other uncultivated soils
Bacillus palustris var. gelaticus Sickles
and Shaw lloc. cit, 419). A variety that
decomposes agar slightly. Found only

once.

Bacillus paucicutis Burchard. [Arbbakt. Inst. Karlsruhe, 2, Heft 1, 1902, 27.) From rye bread.

Bacillus pectocutis Burchard. (Arb bakt. Inst. Karlsruhe, 2, Heft 1, 1902,

24.) From the air.

Bacillus pelagicus Russell. (Bot
Gaz., 18, 1893, 383.) From sca water and
marine mud from Woods Hole, Massa.

chusetts.

Bacillus pellucidus Soriano. (Revista

del Instit. Bacteriol., Buenos Aires, 6, 1935, 567.) Author says colonies resemble Bacillus simplex Habitat probably

in soil

Bacillus peptogenes (Buchanan and Hammer) Bergey et al (Bacterium peptogenes Buchanan and Hammer. Iowa Agr. Evp Sta Res. Bull 22, 1915, 273; Bergey et al., Manual, 1st ed , 1923, 293 ) From a tube of litmus milk after autoclaving.

Bacillus peptonans Chester lus lactis peptonans Sterling, Cent. f. Bakt , II Abt , 1, 1895, 473; Chester, Man. Determ Bact, 1901, 271 ) From milk Very similar to Bacillus mesen-

tericus vulgatus Flugge.

Bacıllus peptonificans Lubenau. (Cent f. Bakt., I Abt , Orig , 40, 1906, 435 ) Similar to Bucilius subtilis Be-Lieved to be the cause of an epidemic of gastroenteritis

Bacıllus perlucidulus Saito (Jour. Coll Sci. Imp Univ., Tokyo, 23, Art. 15, 1908, 43.) Isolated 3 times from

garden air

Bacillus petrolatus Sarto (Jour. Col) Sei , Imp Univ , Tokyo, 23, Art 15, 1908, 48) Isolated twice from garden air Bacillus phaseoli von Wahl (Cent f

Bakt, If Abt, 16, 1906, 500) From canned beans

Bacillus phenolphilos Bartels (Cent. f Bakt , II Abt , 103, 1940, 21 ) Good growth on media containing M/50 phenol. One culture isolated from soil

Bacıllus picragenes Patrıck and Werkman (Iowa State Coll. Jour. Sci. 7. 1933, 410 ) Ferments xylan One culture isolated from decayed watermelon.

Bacillus piliformis Tyzzer (Jour Med Research, 57, 1917, 307.) All attempts to cultivate the organism failed 

Japanese waltzing mice.

Bacillus piscicidus Migula. (Bacillus niscicidus agilis Siebert, Gazeta lekarska. 1895, No 13-17; abst. in Cent. f. Bakt...

17, 1895, 888. Bacterium viscicidus amlis Chester, Ann. Rept. Del. Col. Agr. Exp Sts , 9, 1897, 140; Migula, Syst. d Bakt., 2, 1900, £52, Bacıllus viscicidus nobilis (sic) Babes and Riegler, Cent. f. Bakt., II Abt., Orig., 33, 1902-03, 440.) Cause of a fish epidemic in St. Petersburg

Bacillus pisi von Wahl, (Cent. f. Bakt., II Abt., 16, 1906, 502.) From young peas.

Bacillus platuchoma Gray and Thornton. (Cent f. Bakt, II Abt., 73, 1928, 93 ) Phenol is attacked Three strains isulated from soil.

Bacillus plexiformis Goadby (Dental

Cosmos, 42, 1900, 322 ) From the mouth Bacillus plicatus Dectien. (Dectien. Inaug. Diss., Würzburg, 1890; not Bacil-Jus plicatus Frankland and Frankland, Philos Trans. Royal Soc. London, 178, B. 1887, 273; not Bacillus plicatus Zimmermann, Bakt. unserer Trink- u. Nutzwässer, Chemnitz, I Reihe, 1890, 54; not Bacillus plicatus Copeland, Rept. Filtration Commission, Pittsburgh, 1899, 348; not Bacillus plicatus Chester, Man Determ. Bact., 1991, 275.) sausage

Bacillus pollacii Pavarino. (Atti R Accad Naz Lincei Rend Cl. Sci. Fis. Math e Nat.; 20, 1911, 233 ) Beported to cause depressed spots on leaves of Odantoolossum citrosmum.

Bacillus populi Brisi. (Atti Cong Nat Ital, Pom, della Soc. Ital, di Sci. Nat. Milano, 1907, 376 ) Reported as cause of galls on branches of poplar trees (Populus sp )

Bacillus pseudanthracis Kruse (Milzbrandahnlicher Bacillus, Burri, Hyg. Rundschau, 4, 1891, 339, abst. in Cent. f. Bakt , 16, 1891, 374; Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 233; not Bacillus pseudanthracis Wahrlich, Bakteriol Studien, Petersburg, 1890-91, 26; Bacillus pseudo-anthracis Chester, Man. Determ. Bact., 1901, 280.) From South American bran.

Bacillus pseudococcus Migula (Bacillus No. 11, Pansini, Arch. f. path. Anat., 122, 1890, 446; Migula, Syst. d. Bakt., 2, 1900, 557.) From sputum.

Bacillus pseudodiphlhericum magnus Odegaard. (Acta Path. et Microbiol. Scand., 21, 1914, 451; see Endicott, Biol. Abst., 20, 1916, 12926.) From the mose of a child suspected of having diphtheria. Resembles Corynebacterium diphtheriae in young cultures. Non-pathogenie

Bacillus pscudofusiformis Saito. (Jour. Coll. Sci., Imp. Univ., Tokyo, 23, Art. 15, 1908, 47) Isolated once from garden air.

aruen a

Bacillus pseudosubtilis Migula. (Bacillus subtilis similis Sternberg, Manual of Bact., 1893, 679; Migula, Syst. d. Bakt., 2, 1900, 618.) From the liver of a yellow fever endayer.

Bacillus punctiformis Chester. (Bacillus No. 23, Conn, Storrs Agr. Exp. Sta. Ropt., 1893, 53; Chester, Man. Determ. Bact., 1901, 284.) From milk.

Bacillus pyenoticus Grohmann. (Cent. f. Bakt., II Abt., 61, 1924, 261; Ruhland and Grohmann, Jahrb. wissenseh. Botanik, 63, 1924, 261; Hydrogenomonas pyenotica Bergey et al., Manual, 3rd ed., 1930, 34.) Oxidizes hydrogen in the presence of oxygen to form water. Presumably widely distributed in soil.

Bacillus quercifolius Destjen. (Deetjen, Inaug. Diss., Wurzburg, 1890; Bacterium quercifolium Migula, Syst. d. Bakt. 2, 1900, 309.) From sausage

Bacillus rarerepertus Schieblich. (Cent. f. Bakt, 1 Abt, Orig., 124, 1932,

269.) From beet leaves.

Bacillus rarus Wenner. (Cent. f. Bakt., 11 Abt., 87, 1933, 456.) Good growth on Ca n-butyrate agar One culture isolated from forest soil of Germany

Bacillus repens Gibson. (Cent. f. Bakt., Il Abt., 92, 1935, 370.) Decomposes urea Eight strains isolated from soil.

Bacillus reptans Ghosh. (Compt. rend. Soc. Biol , Paris, 88, 1922, 914.) From a case of appendicitis.

Bacillus retaneus Grohmann. (Morphologisch- biologische Beiträge zu Kenntnis der Wasserstoffnakterien, Inaug. Diss., Univ. Leipzig, 1923; Cent. I. Bakt., II Abr., 61, 1924; 267; Ruhland and Grohmann, Jahrb wissensch- Dolani, 63, 1924, 321.) Oxidizes hydrogen in the presence of oxygen to form water. Pre sumably widely distributed in soil.

Bacillus retiformis Migula (Netzbacillus, Maschek, Bakt. Untersuch d. Leitmeritzer Trinkwasser, Leitments, 1887; Migula, Syst. d. Bakt., 2, 1900, 712)

From water.

Bacillus robustus Weiss (Weiss, Arb bakt. Inst. Karlsruhe, 2, Heft 3, 1922, 247; not Bacillus robustus Blau, Cent f Bakt., II Abt., 16, 1905, 134.) From formenting beets.

Bacillus ruber Zimmermann. (Zimmermann, Die Bakt. unferer Trink u Nutzuässer, Chemnitz, 1, 1890, 21; not Bacillus ruber Cohn, Beitr. z. Biol d Pflanz., 1, Holt 3, 1875, 181; Bacillus pseudoruber Migula, Syst d. Bakt, 4, 1900, 850; Erythrobacillus ruber Holland, Jour. Bact, 5, 1920, 223, line 15; Serata rubra Bergey et al., Manual, 1st ed. 1923, 92; Chromobacterium ruber Topker and Wilson, Princip. of Bact. and Immun., 1, 1931, 402.) From Chemnit tap water. Spherical spores. See Manual, 5th ed., 1939, 607 for a description of this species

Bacillus rufescens Stuhrk. (Cent. I Bakt., 11 Abt., 33, 1935, 178.) Charaterized by good growth on Can-butyrate agar. One culture isolated from garden soil of Germany.

Bacillus rufulus Saito. (Jour. Coll Sci., Imp. Univ., Tokyo, 23, Art. 15, 1903, 50) Isolated 3 times from garden air.

Bacıllus rugosus Henrici. (Henrici. Arb. hakt. Inst. Karlsruhe, I. Heft J. 1891, 28; not Bacıllus rugosus Wright. Mem. Nat. Acad. Sci., 7, 1805, 433; not Bacillus rugosus Chester, Man. Determ Bact., 1901, 220.) From Swiss cheese from Swiss cheese.

Bakt., II Abt., 93, 1935, 181.) One of s

group of species described as growing well on Ca n-butyrate agar Three strains isolated from soils of Germany,

Cuba, and Italy.

Bacillus sacchari Janse. (Mededeel. ut's Lands. Plantentuin, 9, 1891, 1) Reported to cause serch, a disease affecting sugar cane (Saccharum officinarum) Went (Arch. voor de Java Suikerindustrie, 1895, 589) regards this as probably Bacillus subtlis

Bacillus saccharolyticus Nepomnjatschipja and Libermann (Jour f Mikrobiol., Ukraine, 5, 1933, 57; abst in Cent f Bakt, II Abt, 101, 1940, 81) From plum preserves A gas-producing rod.

Bacillus saccobranchi Dobell (Quart Jour Micro. Sci., 56, 1911, 441) From heart blood of a fish (Saccobranchus fossilis)

Bacillus santiagensis Stührk. (Cent f Bakt., II Abt., 33, 1935, 183) Good growth on Ca n-butyrate agar One culture isolated from Cuban soil

Banilus approgenes Nigula. (Bacillus approgenes in III, Kramer, Bakterologie in ihren Beziehungen zur Landwytschaft, 2, 1902, 137; Migula, Syst. d. Bakt., 2, 1900, 572; not Bacillus seprogenes I, II and III, Herfeldt, Cent. f. Bakt., II. Abt., I, 1995, 77, not Bacillus seprogenes Salus, Arch. f. Hyg., 61, 1991, 115) From wine.

Bacillus saprogenes Chester (Bacillus saprogenes vin VI, Kramer, Bakteriol Landwittsch., 2, 1892, 139; Chester, Man Determ Bact., 1901, 289, not Bacillus saprogenes Trevisan, I generi e le specie delle Batteriacce, 1889, 17) From wine

Bacillus scaber (Duclaux) Trevisan (Tyrothrix scaber Duclaux, Ann Inst. Nat Agron, 4, 1882, 23; Trevisan, I generi e le specie delle Batteriacce, 1889, 16) Fron milk.

Bacillus schollelii Trevisan. (Darmhacillus, Lydtin and Schottelius, Der Rotlauf der Schweine, Weisbaden, 1885, 214, Bacillus coprogenes foefulus Flügge, Die Miknorganismen, 2 Auff., 1886, 305, Trevisan, I generi e le specie delle Batteriacee, 1889, 17; Bacterium coprogenes Migula, Syst. d Bakt., 2, 1900, 327; Bacterium schottelii Chester, Man. Determ. Bact., 1901, 197.) From the untestinal contents of syme.

Bacillus segetalis Werner. (Cent. f Bakt, II Abt, 87, 1933, 467) Characterized by growth on Can-butyrate agar. One strain isolated from soil in Germany.

Bacillus septico-aerobius Hauduroy et al. (Bacille septique aérobie, Legros, Thèse Méd, Parıs, 1992; Hauduroy et al., Diet. d Bact Path, 1937, 46) Aerobic, facultative. From a case of acute gaseous ganerone.

Bacillus septicus insectorum Krassilstschik (Memoires de la Soc. Zool de France, 6, 1893, 250.) From cockchafer larvae (Metolontha melolontha).

Bacillus serrulatus Stührk. (Cent f. Bakt, II Abt., 93, 1935, 193.) Only moderate growth on Can-butyrate agar. One culture isolated from Cuban soil.

Bacillus sesami Malkoff (Cent. f. Bakt, II Abt., 16, 1906, 665) Pathogenic on sesame (Sesamum).

Bacillus siccus Chester. (Bacillus No. 25, Conn, Storrs Agr Exp. Sta Rept, 1893, 63; Chester, Man Determ. Bact, 1901, 284) From milk.

Bacillus sumilas Schroeter. (Bacillus II, Bienstock, Zischr & Ilin. Medi., 8, 1884, Heft I and 2; Schroeter, in Cohn, Kryptog -Flora v. Schlesien, 3, 1, 1889, 160, Bacillus coprocinus Trevisan, 1 generi ele specie delle Batteriacee, Milan, 1889, 15, Bacillus facedais No II, Kruse, in Flüge, Die Alikroorganismen, 3 Aufl., 2, 1896, 215, Bacterium sumile Chester, Man Determ Bact., 1901, 197.) From fecces

Bacillus similis Eckstein (Arch f. Forst- u Jagdwesen, 26, 1891, 11.) From infested larvae of the nun moth (Lymantria manacha), etc.

Bacillus similityphosus Migula. (Typlusähalicher Bacillus, Maschek, Bakt. Untersuch d Leitmeritz. Trinkwässer, Leitmeritz, 1887; Migula, Syst. d. Bakt., 2, 1900, 730) From water Bacillus sinapiragus Kossowicz. (Cent. f. Bakt., 11 Abt., 23, 1909, 241.) From pickles.

Bacillus sombrosus Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 429.)

From the stomach of a bird.

Bacillus sorghi Burrill. (The Microscope, 7, 1857, 321; Proc. Amer. Soc. Microscopists, 1858, 193; Bacterium sorghi Chester, Delaware Agr. Exp. Sta. Ann. Rept., 9, 1897, 127; Elliott and Smith, Jour. Agr. Res., 58, 1923, 1.) Reported to cause a disease of sorghum (Holeus sorghum)

Bacillus sotto l'aillot. (Sotto-Bacillus, Ischivata, quoted from Aoki and Chi-gasaki, Mitteil. d. Mcd Fakul. d. k. Univ. z. Tokyo, 13, 1915, 419 and 14, 1915, 59; Batterium sotto Metalnikov and Chorine, Internat Corn Borer Invest., Sci Repts., 1, 1928, 56, Paillot, ibid., 1, 1928, 77-196.) From silkworms (Bombyz mori). Sotto is Japanese for "plotzlich hinfallen".

Bacillus spatiosus Saito. (Jour. Coll. Sci., Imp Univ., Tokyo, 25, Art. 15, 1908, 56.) Isolated once from garden air.

Bacillus spermatosoides Eckstein. (Ztschr. f. Farst- u. Jagdwesen, 26, 1894, 13.) From dead maths (Hyponomeuta eronymella).

Bacillus sphaerosporus Beijerinck. (Cent. f. Bakt., II Abt., 25, 1999, 45.) This organism has round terminal spores and produces nitrous oxide from nitrates From garden soil.

Bacillus sphaerosporus calco-acelicus Beijerinck (loc cit., 46). A variety of the above having spherical to ellipsoidal spores.

Bacillus spinosporus Sotiano. (Thesis, Univ. Buenos Aires, 1935, 562.) Spores spinate like some strains of Bacillus polymyra. No gas formed. One strain isolated from soil. Bacillus spiralis Migula. (Syst. d.

Bakt., 2, 1900, 624.) From water.

Bacillus spirogyra Dobell (Quart Jour. Micro. Sci , 53, 1909, 579 and 58, 1911, 434) From large intestine of frog (Rana temporaria) and toad (Buso vulgaris). Bacillus spongiosus Aderhold and Ruhland. (Cent. f. Bakt., 11 Abt., 15, 1905, 376.) Found in the gum masses discharged by cherry trees.

Bacillus sporonema Schnudinn. (Arch f. Protistenkunde, 2, 1903, 421.) From

sea water.

Eacillus spurius Grohmann. (Morphologisch-biologische Beiträge sur Kemutnis der Wasserstoffhukterien, Inaug. Dies., Univ. Leipzig, 1923; Cent. Pakt., 11 Abt., 61, 1924; 267; Rublaud and., 11 Abt., 61, 1924; 267; Rublaud and Grohmann, Jahrb. wissensch Botanik, 63, 1924, 321.) Oxidizes lydogen in the presence of oxygen to form water. Presumably widely dustributed in soil.

Bacillus sputi Chester. (Bacillus No 6, Pansini, Arch. f. path. Anat., 123, 1890, 442; Chester, Man. Determ. Bact., 1901, 280) From sputum.

Bacillus squamiformis Saito. (Jour. Coll Sci., Imp. Univ., Tokyo, 23, Art 15, 1908, 54.) Isolated 9 times from garden soil.

Bacillus stellaris Saito. (Jour. Coll. Sci., Imp. Univ., Tokyo, 23, Art. 15, 1988, 52.) Isolated 6 times from garden air.

Bacillus stellatus Zimmermann. (Zimmermann, Bakt. unserer Trink- u. Nützuasser, II Reihe, 1894, 14; not Bacillus stellatus Chester, Man. Determ. Bach, 1901, 274; not Bacillus stellatus Vinceni, Ann. Inst. Past., 21, 1907, 62.) From nater.

Bacillus streptoformis Migula. (Salpeter zeratóreaden Bacillus, Schirokith. Cent. f. Bakt., II Abt., §, 1886, 20; Migula, Syst. d. Bakt., §, 1900, 62; Bacillus schirokithi Chester, Man. Determ. Bact., 1901, 252; Bacillus denitrificans Chester, 10th, 274.) From hore feces Utilies potassium nitrate.

Bucillus suaveolens Sclavo and Gosio. (Quoted from Omeliansky, Jour. Bact.,

(Quoted from Omeliansky, Jour. Backs, 8, 1923, 393.) No source given.

Bacillus subcuticularis Migus. (Bacillus cuticularis albus Tataroli, Aug. Diss., Darpst, 1891, 24; Miguls, Syst. d. Bakt., 2, 1900, 623; Bacillus cutrusfaris Chester, Man. Determ. Bact, 1901, 285.) From water. Bacillus sublanatus Wright. (Mem. Nat Acad. Sci., 7, 1895, 455 ) From water.

Bacillus sublustris Schieblich. (Cent. f Bakt., II Abt., 68, 1923, 206.) Commonly isolated from green and fermenting fodders.

Bacillus submarinus ZoBell and Upham (Bull, Scripps Inst of Oceanography, Univ Calif, 5, 1944, 267) Central ovate spores. From marine hottom deposits.

Bacillus (Streptobacter) subtiliformis (Bacillus I, Bienstock, Schracter. Ztschr f klin Med , 8, Heft 1 and 2, 1884, Schroeter, in Cohn, Kryptog -Flora v Schlessen, 3, 1, 1886, 160, Bacillus mesenthericus (sic) Trevisan, I generi e lo specie delle Batteriacco, Milan, 1889, 15. not Bacillus mesentericus Trovisan, thid . 19: Bacillus subtilis simulans I. Eisenberg, Bakt Diag 3 Aufl, 1891. 189. Bacillus faecalis No. I. Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1898, 215, Bactersum subtite Migula, Syst d Bakt . 2, 1900, 272, Bacterium subtrlifarme Chester, Man Determ Bact , 1901, 197 ) From feces.

Bacillus succinicus Fitz (Quoted from DeToni and Trevisan, in Saceardo, Syllogo Fungorum, 8, 1889, 966) From Infusions.

Bacallus zuffuscus Grolmann. (Morphologisch-biologische Beiträge zur Kenntnis der Wasserstofflakterien, Inaug Diss., Univ. Leipzig, 1923, Cent f Bakt, If Abt, 64, 1924, 297, Rubland and Grobmann, Jahrb wissensch. Botanik, 65, 1921, 321 ) Ovidizes hydrogen in the presence of ovygen to form water Presumably widely distributed in soil.

Bacillus supraresistans Stührk. (Cent f. Bakt., II Abt., 93, 1935, 185.) Very good growth on Can-butyrate agur One culture isolated from soil in Cermany.

Bacillus aurgeri Dornic and Daire. (Bull. mensuel de l'Office de renseignements agricoles, 6, 1907; abst. in Rev. Cén. du Lait., 6, 1907, 161.) Spores not observed but author stated that they were probably present because this

apecies could withstand 85°C for 5 minutes From whey.

Bacillus tabaci III, Koning. (Tijdschr. voor toegepaste scheikunde en hygiene. Deel I, 1897. See Behrens, Mykologie der Tabakfabrikation, in Lafar, Handbuch der teelm Mykologie, 6, 1905, 11.) Thermophiliic. Probably from soil

Bacillus tardirus Stuhrk. (Cent. f. Bakt, II Abt, 95, 1935, 177.) Very alight growth on Ca n-butyrate agar. One culture isolated from garden soil of Germany

Bacillus technicus Morikawa and Prescott. (Jour Bact, 15, 1927, 53; also sec Morikawa, Bull Agr Chem. Soc. Japan, 5, 1927, 28) Produces butyl and isopropyl alcohols Source not given.

Bacillus tenax Eckstein (Ztschr. f. Forst u Jagdnesen, 20, 1894, 14) From larvae of the nun moth (Lymantria manacha).

Bacillus tenuis nan-liquefaciens Choukévitch (Ann Inst Past, 25, 1911, 352) From large intestine of horse

Bacillus terminalis Migula. (Bacillus No XII, Fluge, Ztschr. I. Hyg. 17, 1894, 296; Bacillus No. XII, Kruse, in Fluege, Die Mikroorganismen, 3 Aufl., 2, 1806, 209, Migula, Syst. d. Bakt., 2, 1900, 578; Bacillus lacteus Chester, Man. Determ. Bact., 1901, 291.) From milk. A dupheate of Bacterium semper-viewn Migula.

Bacillus terminalis var thermaphilus Frickett. (N. Y. Agr. Exp Sta. Tech. Bull. 147, 1928, 44.) Produces a brown water soluble pigment on agar; optimum temperature 55°C to 65°C. Fourteen atrains from raw and pasteurized milk, milk powder, and skin of a cow.

Bacillus terrestris Werner. (Cent. f. Bakt, II Abt., 87, 1933, 461.) Weak growth on Ca n-butyrate agar. Two atrains isolated from soils of Cermany.

atrains isolated from soils of Cermany.

Bacillus tetanoides Saito. (Jour. Coll.
Sei, Imp Univ., Tokyo, 25, Art. 15.

1903, 49 ) Isolated once from garden air. Bacillus Italiassokoites ZoBell and Upham. (Bull. Seripps Inst. of Occanography, Univ. Calif., 5, 1914, 203.) Central spores. From marine bottom deposits. Bacillus theae Hori and Bokura. (Jour. Plant Protection, Tokyo, 2, 1915, 1.) Pathogenic for tea (Thea sinensis).

Bacillus thermoabundans Beaver. Dissertation, Ohio State University. Columbus, 1932, 31.) Thermophilits, supterminal spores. Growth at 55°C, less growth at 37°C. From malted milk powder.

Bacillus thermoaceligenitus Beaver, loc. cit., 25. Thermophilic, central spores. No growth at 37°C. From vinegar.

Bacillus thermoacidificans Renco. (Aun. Microbiol., 2, 1942, 600) From Grana cheese whey. This is stated by Gorini (R. 1st. Lombardo Sci. c. Lett., Rend., 76, 7° della Ser. 3, 1942, 3) to be the same as Bacillus lactis termophilus Gorini.

Bacillus thermoactivus Beaver, loc. cit., 27. Thermophilic, central spores. No growth at 37°C. From home-canned beets.

Racillus thermoonnulatus Beaver, loc. cit., 17. Thermophilic, subterminal spores. No growth at 37°C. From commercially canned tomatoes

Bacillus thermoaquatilis Benver, loc. cit, 18. Thermophilic, subterminal spores. No growth at 37°C. From a warm string at Springfield, Obio.

Bacillus thermoarborescens Beaver, loc. cit., 30. Thermophilic, sub-terminal to central spores. Growth at 55°C, less growth at 37°C From candy.

Bacillus thermobutyrosus Beaver, loc. c.t., 15. Thermophilic, subterminal spores. No growth at 37°C. From commercially canned tomatoes.

Bacillus thermocompactus Beaver, loc. 1ct., 20. Thermophilic, subterminal spores. No growth at 37°C. From red grapes stored in sawdust.

Bacillus thermodactylogenitus Heaver, loc. cit., 28. Thermophilic, central to subterminal spores Growth at 37°G and 55°C. From commercially packed dates.

Bacillus thermoeffervescens Beaver, loc.

cit., 23. Thermophilic, central spores No growth at 37°C. From commercially canned peas.

Bacillus thermofaccalis Beaver, loc cit., 30. Thermophilic, subterminal spores. Growth at 55°C. From leces of robin.

Bacillus thermofibrincolus Itano and Arakawa. (Ber. d. Ohara Inst. i. landwirsch. Forschungen, Japan, 4, 1929, 265) Thermophilic; decomposes cellulose. From soil containing decomposed leaves.

Bacillus thermofiliformis Beaver, loc. cit., 22. Thermophilic, subtermind spores. No growth at 37°C. From commercially canned peas.

Bacillus thermograni Beaver, loc. ci., 16. Thermophilic, subterminal spores No growth at 37°C. From commercially canned corn.

Bacillus thermolongus Beaver, loc. cil., 19. Thermophilie, subterminal spores No growth at 37°C. From commercially canned tomatoes.

Bacillus thermoludricans Beaver, lec. cit., 26. Thermophilic, central spores No growth at 37°C. From lubricating oil.

Bacillus thermononodorus Beaver, loc. ett., 26. Thermophilic, central spores No growth at 37°C. From tap water.

Bacillus thermonubilosus Beaver, loc. cit., 19. Thermophilic, subterminal spores. No growth at 37°C. From soil, Yellow Springs, Ohio.

Bacillus thermoodoratus Beaver, loc. cit., 29 Thermophilic, central spores Growth at 55°, less growth at 37°C From spoiled gelatin.

Bacillus thermopellitus Beaver, loc cit., 22. Thermophilie, central spore. No growth at 37°C. From old sour mile Bacillus thermophilus Muque! (Mr. quel, Ann. d. Microgr., 1, 1888, 4, Bacillus thermophilus miquelit Kruse, as Flugge, Die Mikroorganismen, 3 Auf., t, 1896, 260; Bacterium termophilum (sc) Migula, Syst. d. Bakt., 2, 1900, 32°; Bacterium miquelit Chester, Man.Determ. Bact., 1901, 186.) From the intestine, water and soil. Thermophilic. No growth below 40°C Bacillus thermophilus sojae Rokusho

and Fukutome. (Jour. Agr. Chem Soc., Japan, 15, 1937, 1235) From spontaneously heating soy-bean cake.

Bacillus thermosuavis Beaver, loc cit., 24 Thermophilic, central spores No growth at 37°C. From commercially canned mincement.

Bacillus thermotenax Beaver, loc cit., 28 Thermophilie, subterminal spores. Crowth at 37°C and 55°C From ground horsemdish.

Bacillus thermourinalis Beaver, loc. cit, 16. Thermophilic, subterminal spores. No growth at 37°C. From human urine.

Bacillus thermoniscidus Beaver, loc. cit, 21 Thermophilic, subterminal spores. No growth at 37°C. From fresh pg overy

Bacillus thoracis Honard (Cleanings in Bec Culture, 28, 1900, 124) From black brood of the honey bes (Apis mellifera).

Bacillus tracheitis sive graphitosis Krassilstschik (Memoires de la Soc Zool de France, 6, 1893, 250) From diseased larvas of the cockchafer (Melolontha melolontha).

Bacillus tricomii Trevisan (Bacillo della gangraena senilia, Tricoms, Riv. internaz di Med e Chir, 5, 1886, 73, Trevisan, I generi e le specie delle Batteracce, 1889, 13; Bacterium tricomii Migula, Syst. d Bakt, 2, 1900, 310) From a case of senile zangrene

Bacillus trifolis Voglino. (Ann R. Accad Agr. Torino, 39, 1896, 85) Pathogenic for clover (Trifolium pratense, T.

repens, T. resupinalum).

Bacillus tritus Batchelor. (Jour.
Bact, 4, 1919, 29.) One culture from
feces.

Bacillus tuberis von Wahl (Cent. f. Bakt., II Abt., 16, 1906, 593) From cooked truffles (Tuber oestirum)

Bacillus tuberosus Weiss. (Arb. bakt

Inst Karlsruhe, 2, Heft 3, 1902, 248) From fermenting beets

Bacillus lubifez Dale. (Annals of Bot., 25, 1912, 133.) Reported to cause a leaf disease of potato (Solanumtuberosum) and toroato (Lycopersicum esculenium).

Bacillus turgidus (Duclaux) Trevisan. (Tyrothriz turgidus Duclaux, Ann. Inst. Nat. Agron, 4, 1882, 23; Trevisan, I generi e le specie delle Batteriacee, 1889, 16) From milk.

Bacillus tympani-cuniculi Morcos. (Jour. Bact, 23, 1932, 454.) Causes tympanitis in young rabbits

Bacillus ubicuitarius Soriano. (Estudio sistematico de algunas bacterias esporuladas aerobias, Thesis, Univ. Buenos Aires, 1935, 569) Four cultures isolated from soil.

Bocillus ulna Cohn. (Cohn, Beitr. z. Bsol d. Pflanz., 1, Helt 2, 1872, 177; also see Prasmowski, Untersuch. ti. d. Entwickelungsges. u Fermentwirk. einiger Bakterienarien, Lelpzig, 1850, 20.) Found once in an infusion of cooked egg-white

Bacillus undulatus den Dooren de Jong (Bull Assoc. Diplômés de Microbiol. Nancy, No. 26-27, 1946, 12) From soil.

Bacillus uvaeformis Kern. (Arb bakt. Inst Karlsruhe, 1, Heft 4, 1896, 415.) From the stomachs and intestines of birds. Bacillus vaculatus Ravenel. (Mem.

Nat Acad Sci., 8, 1896, 31.) From soil.

Bacillus talidus Ileigener. (Cent. f.
Bakt., II Abt., 93, 1935, 97.) Four
cultures isolated from soil from Cermany, Cuba, and Egypt.

Bacillus ralinatorans Heigener. (Cent. f Bakt., 11 Abt, 93, 1935, 101)

Bacillus varians Saito. (Jour. Coll. Sei., Imp. Univ., Tokyo, 23, Art. 15, 1908, 50) Isolated 11 times from garden air.

Bacillus rentricosus Heigener. (Cent.

f. Bakt., II Abt., 93, 1935, 102; not Bacillus ventricosus Weiss, Arb. bakt. Inst. Karlsruhe, £, 1898, 233.) One culture isolated from soil from Italy.

Bacillus ventriculus Koch. (Botan. Zeitung, 46, 1888, 341.) From slices of carrot exposed to the nir. Formed two spores in a spindle-shaped sporangium.

Bacillus vernicosus Zimmermann. (Bakt. unserer Trink- u. Nutzwässer, Chemnitz, II Reihe, 1894, 46; not Bacillus rernicosus Migula, Syst. d. Bakt., 2. 1900, 781.) From waste water.

Bacillus verticillatus Ravenel. (Ravenel, Mem. Nat. Acad. Sci., 8, 1896, 13: Bacterium verticillatum Chester, Man. Determ. Bact., 1901, 192.) From soil.

Bacillus resicae Migula. (Bacillus septicus vesicae Clado, quoted from Eisenberg, Bakt, Diag., 3 Aufl., 1891. 341; Migula, Syst. d. Bakt., 2, 1900, 620.) From urine in a case of cystitis. Probably is Bacillus clado: Trevisan.

Bacillus villosus Zimmermann. (Bakt. unserer Trink- u. Nutzwässer, Chemnitz, II Reihe, 1894, 38; not Bacillus villosus Keck, Inaug. Diss., Dorpat, 1890, 47.)

From water. Bacillus violaceus Eisenberg. (Bakt. Diag., 2 Aufl , 1888, 8; not Bacellus violaceus Schroeter, Kryptogamen-Flora von Schlesien, 3, 1886, 157; not Bacillus violaceus Frankland and Frankland, Ztschr. f Hyg., 6, 1888, 394.) Said to produce central spores. From water, Bacillus viridi-alaucescens Sack.

(Cent. f. Bakt., 11 Aht., 65, 1925, 113)

From several kinds of soil. Bacillus viridiluteus Pagliani et al.

(Grungelber, nicht verflussiger Bacillus, Eisenberg, Bakt. Diag, 1 Aufl., 1886, Tab. 6; Pagliani, Maggiora and Fratini, Soc. ital d'igiene, 1887, 586, see Trevisan, I generi e le specie delle Batteriacee, 1889, 19). From water

Bacıllus viscosus bruxellensis van Laer. (Cent. f. Bakt., II Abt., 25, 1909, 159.)

From beer wort.

Bacillus esticola Burgwitz (Bacıllus vitis Merjanian and Kovaleva, Prog. Agric. et Vitic., 95, 1930, 594 and 98, 1931.

17; nnt Bacillus vitis Montemartini, Rev. Patol. Veg., 6, 1913, 175; Burgwitz. Phytopatb. Bacteria, Leningrad, 1935, 37.) Pathogenic for the grape vine.

Bacillus vitreus Migula (No. 11, Lembke, Arch. f. Hyg., 26, 1896, 306; Migula, Syst. d. Bakt , 2, 1900, 569 } From the intestines of infants.

Bacillus vogelii Migula. (Roter Kartoffelbacillus, Vogel, Ztschr. f. Hyg , 26, 1897, 404; Migula, Syst. d. Bakt., 2, 1900, 556; Bacillus viscosus Chester, Man. Determ. Bact., 1901, 286; not Beeillus viscosus Frankland and Frankland. Ztscbr. f. Hyg., 6, 1889, 301.) From stringy bread.

Bacillus watemannii Werner. (Cent.f. Bakt., II Abt., 87, 1933, 462.) Weak growth on Ca n-butyrate agar. One culture isolated from soil of Germany.

Bacillus weigmanni Migula. (Bakterie II. Welgmann and Zirn, Cent f. Bakt., 15, 1894, 465; Migula, Syst. d Bakt., 2, 1900, 693.) From soapy milk.

Bacillus xylanicus Patrick and Werkman, (Iowa State Coll. Jour. Sci. 7, 1933, 415.) Ferments xylan. One culture isolated from decayed apple wood.

Bacillus xylophagus Patrick and Werkman. (Iowa State Coll. Jour. Sen., 7, 1933, 414.) Ferments xylan. One culturo isolated from decayed apple mood

Bacillus zirnii Migula. (Bakterie III, Weigmann and Zirn, Cent. f. Bakt., 15, 1894, 466; Migula, Syst. d. Bakt , 2, 1907,

693.) From soapy milk. Bacterium adametzii Migula. (Bacillus Na. XIV, Adametz, Landwirtsch. Jahrb., 18, 1889, 246; Migula, Syst. d Bakt., 2, 1900, 338; Bacterium rugosum Chester, Man. Determ. Bact., 1901, 194.)

From cheese. Bacterium aloes Passalacqua. (Rev. Pat. Veg., 19, 1929, 110.) From diseased

aloes Bacterium angulans Burchard. (Inaug. Diss., 1897; Arb. bakt. Inst. Karlsrube, 2, Heft 1, 1902, 43 ) From water.

Bacterium aqueum Migula. (Bacillut Rabinowitsch, VIII, thermophilus Ztsebr. f. Hyg., 20, 1895, 160; Miguls,

Syst. d. Bakt., 2, 1900, 345; Bacterium thermophilum VIII, Chester, Man. Determ. Bact., 1901, 186.) From feecs

and corn

Bacterium articulatum Kern. (Arb. bakt Inst. Karlsruhe, 1, Heft 4, 1897, 445.) From the stomach and intestines of birds.

Bacterium asparage von Wahl (Von Wahl, Cent f. Bakt, II Abt., 16, 1906, 498; Bacillus asparagi Lehmann and Neumann, Bakt, Diag, 4 Auff, 2, 1907, 436 ) I'rom boiled asnaragus

Bacterium brachysporum Burchard. (Inaug Diss., 1897; Arb. bakt, Inst. Karlsruhe, 2, Heft I, 1902, 20 ) From

bakery bread.

Bacterium canadensis Chorino (Internat. Corn Borer Invest., Sei Rpts., 2, 1929, 39; also Ann. Inst. Past., 45, 1929, 1658: Bac, canadensis Chorine and Metalnikov, Ann Inst Past, 43, 1929, 1392; also Paillot, L'infection cher les insectes, 1933, 134 where Bac, equals Bacterium, see index p 522; Barillus canadensis Steinhaus, Bacteria Associated Extracellularly with Insects, Minneapolis, 1942, 50) In its general characters said to resemble Bacillus megathersum and other bacteria isolated from insecta (Bacillus thuringiensis, Bacillus hoplosternus, etc ). Pathogenie for larvae of Pyravsta nubilalis, Galleria mellonella, and Ephestia kuhniella From diseased lary so of the corn borer

Bacterium cattleyae Pavarino (Atti R Accad. Naz Lincei Rend Cl. Sci. Fis., Mat. e. Nat., 20, 1911, 233.) From

diseased orchids.

Racterium cazaubon Metalnikov. (Compt. rend. Soc. Biol., Paris, 105, 1930. 536; two varieties, Bacterium cazaubon I and II are recognized by Metalnikov, Ermolaev and Schobaltzyn, Internat Corn Borer Invest., Sci. Repts , 5, 1930, 30 and Ann. Inst. Past 49, 1931, 469 ) From diseased corn borer larvae (Purausta nubilatis 11b ).

Bacterium christies Chorine. (Internat. Corn Borer Invest., Sci. Rpts , 2, 1929, 46; also Ann. Inst. Past., 45, 1929, 1666.) According to the author, this closely resembles Racterium ontarioni. Several atrains isolated from diseased corn borers.

Bactersum colomatri Chester. (Colomatii, Breslayer arztliche Ztschr., 1883. No. 4; Chester, Man. Determ. Bact., 1901, 186 ) From xerotic masses in conjunctivitis.

Bacterium deliense Swellengrebel. (Archiv f Protist , \$1, 1913, 277.) Obgerved in stained smears from the spleen of diseased cattle but not isolated Two spores may form in a single cell if division is delayed.

Bacterium ephestiae No. 1 and No 12 Metalnikov and Chorine. (Ann Ins ) Past , 45, 1929, 1394.) Not pathogenia for corn borer although the size of this larvae was reduced. Later, Ellinger \. and Chorine (Internat, Corn Borer Investigations, Sei Rpts , 5, 1930, 37) identified these as atrains of Barellus; , thuringiensis. From diseased larvae of . Ephestia Luchniella.

Baclerium filiforme Henriei. (Henrici, Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1801, 41, not Bacterium filiforme Migula, Syat. d. Bakt , 2, 1900, 296; Bacterium subfiliforme Migula, abid., 297 ) From Saiss cheese.

Bacterium galleriae No. 1. Chorine. (Batonnet mince, Metalnikov, Compt. rend. Acad. Sci., Paris, 175, 1922, 69; Chorine, Ann. Inst. Past , 41, 1927, 1115.) From diseased larvae of the bee moth (Galleria mellonella).

Bacterium galleriae Chorine, (Plus grand batonnet, Metalnikov, Compt. rend Acad. Sci , Paris, 175, 1922, 70; Chorine, Compt. rend. Soc. Biol., Paris. 95, 1926, 200, Bacterium galleriae No. 2. Chorine, Ann Past. Inst , 41, 1927, 1117.) From diseased larvae of the bee moth (Gulleria mellonella). Resembles Bacillus megathersum. Pathogenic for the corn borer (Internat, Corn Borer Invest , Sci Repts , 1, 1927, 46).

Baclerium galleriae No. 3, Chorine (Ann. Inst. Past., 41, 1927, 1118 ) From diseased larvae of the bee moth (Galleriae mellonella). Resembles Bacıllus subtilis and Bacillus mesentericus,

Bacterium giganteum Kern. (Arb. hakt. Inst. Karlsruhe, 1, Heft 4, 1896, 453.) From the stomach and intestines of hirds.

Bacterium glauceseens Migula. (Bacillus thermophilus VI, Rabinowitsch, Ztschr. f. Hyg., 20, 1895, 183; Migula, Syst. d. Bakt., 2, 1900, 344; Bacterium thermophilum VI, Chester, Man. Determ. Bact., 1901, 185.) From feess.

Bacterium glutinosum Kern. (Arh. hakt. Inst. Karlsruhe, 1, Heft 4, 1896, 441) From the stomach of a dove.

Bacterium ilidzense Migula. (Bacullus ilidzensis capsulatus Karlinski, Hygienische Rundschau, 5, 1895, 685; Digula, Syst. d. Bakt., 2, 1900, 340.) ) rom the water of a hot spring. Therrapphilic.

Barterium implectans Burchard. (Inabg. Diss., 1897; Arb. hakt. Inst. Karlsruhe/2, Heft 1, 1898, 29.) From drinking water.

Bacterium insulosum Wilhelmy. (Arb. bakt. Inst. Karlsruhe, 3, 1903, 16)
From meat extract.

Bacterium insulum Weiss. (Arb. hakt. Inst. Karlsruhs, & Heft 3, 1902, 252.) From fermenting malt.

Bacterium intactum Migula. (Bactllua thermophilus V, Rahinowitesh, Itsobr. f. Hyg., 20, 1895, 185; Migula, Syst. d. Bakt., 2, 1900, 344; Bacterium thermophilum V, Chester, Man. Determ. Bact., 1901, 185 ) From feces and ooru.

Bacterium irs Migula. (Irisicrender Bacillus, Tataroff, Inaug. Diss., Dorpat, 1891, 57; Migula, Syst. d. Bakt., g. 1900, 313; not Bacterium rris Chester, Ann. Rept. Del. Col. Agr. Exp. Sts., g, 1897, 125.) From water.

Bacterium italicum No. 1 and No. 2, Metalnikov, Ermolaev and Skobaltzyn (Ann. Inst. 1981, 470; No. 2 is also described in Internat. Corn Borer Invest. Sci Repts., 5, 1930, 30.) From larvae of the corn borer (Pyrausta nubilalis).

Bacterium longum Kern. (Kern, Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1894, 391; Bacterium squamosum longum Kern, 1bid., 458; Bacillus squamosus longus Chorine, Ann. Inst. Past, 4!, 1927, 1114.) From the intestines of a dove (Columba oenas).

Bacterium Iunula Dobell. (Quart Jour. Micro. Sci., 63, 1903, 579.) From rectum of the toad (Bufo rulgarii). Resembles Bacterium binucleatum Swellengrebel

Bacterium lydiae Migula. (Bacullus thermophilus I, Rahinowitsch, Zischr. f. Hyg., 20, 1895, 156; Migula, Syst. d. Bakt., 2, 1900, 343; Bacterium thermophilum I, Chester, Man. Determ. Bact., 1901, 185.) Widely distributed in soil, snow, feces, corn.

Bacterium mansfieldii Chester. (Baciflus No. 18, Conn, Storrs Agr. Evpt Sta., 1893, 51; Chester, Man. Determ. Bact., 1901, 197.) From milk.

Bacterium markusfeldii Chester. (Bacillus der trichorthexis nodosa, Markusfeld, Cent. f. Bakt. 1 Abt., £1, 1837, 230; Chester, Man. Determ. Baet., 1901, 192.) Associated with the disease, trichorthexis nodosa.

Bacterium mesentericum Migula. (Bacilium mesentericus panis triscosi I, Vogel, Ztschr. f. Hyg., 29, 1807, 401; Migula, Syst. d. Bakt., 2, 1900, 314; Bacterium panis Chester, Man. Determ. Bact., 1901, 196.) From stringy bread dough.

Bacterium mesenteroides Migula. (Bacillus No. XVII, Adametz, Landr. Jahrh. 18, 1839, 249, Migula, Syst. d. Bakt., 2, 1900, 312; Bacterium viscoum Chester, Man. Determ. Bact., 1901, 194) From cheese.

Bacterium modesium Bersteyn. (Arb bakt. Inst. Karlsruhe, 3, 1903, 95) From soil.

Bacterium monstrosum Henrici. (Arb bakt. Inst. Karlsruhe, 1, Heft 1, 1891, 47.) From Swiss cheese.

Bacterium nephritidis Migula. (Bacillus nephritidis interstitialis Letterich, Ztschr. f. klin. Med., 15, 188-, 33, Migula Syst. d. Bakt., 2, 1900, 310; not Baterium nephritidis Chester, Man Determ. Bact., 1901, 145.) From urine in cases of nephritis.

Bacterium ochraceum Migula. (Ba cillus viscosus ochraceus Freund, Martin Inaug. Diss., Erlangen, 1893, 37; Migula, Syst. d. Bakt, 2, 1900, 333.) From the oral cavity.

Bacterium olivae Montemartini. (Atti Inst Bot Pavia Univ., 2 ser, 14, 1914, 154) From diseased olive branches.

Bacterium paludosum McBeth. (Soil Sci., 1, 1916, 463) Filter paper reduced to a white pulp-mass. From two soils in California.

Bacterium persitomaticum Burchard (Arb. bakt. Inst. Karlsruhe, \$, 1898, 11.) Similar to or identical with Bacillus ruminatus (Gottheil, Cent. f. Bakt., 11 Abt., 7, 1901, 485). From soil.

Bacterium pututans Burchard (Inaug. Diss., 1897; Arb. bakt Inst. Karlsrube, 2, Heft 1, 1898, 8.) From a brown concretion in a cooked egg.

Bacterium plicativum Weiss (Weiss, Arb bakt Inst. Karlsrube, 2, Heft 3, 1902, 223; not Bacterium plicativum Migula, Syst. d. Bakt., 2, 1900, v and 453) Trom fermenting beets and malt

Bacterium plicatum Henrici. (Henrici, Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 49; not Bacterium plicatum Chester, Man Determ Bact., 1901, 166) From brick chesse.

Bacterium pseudacet: Migula (Beellius No. XV, Adametz, Landw. Jahrb., 18, 1890, 217; Migula, Syat. d. Baktr., 2, 1900, 320, Bacterium turgidum Chester, Man. Determ. Bact., 1901, 195.) From cheese Characteristic involution forms very similar to those of Bacillus aceti Hansen.

Bacterium pseudomycoides Migula. (Migula, Syst d. Hakt, £, 1900, 486; Bacillus pseudomycoides roseus Nepveux, Thèse, Fac. Pharm, Nancy, 1920, 112) From soil

Bactersum pseudovermiculosum Sasto-(Jour Coll Sci., Imp. Univ, Tokyo, 25, Art 15, 1908, 62) Isolated twice from garden air.

Bacterium pyrene: No. 1, No. 2 and No. 3, Metalnikov, Ermolaev and Skobaltzyn. (Internat. Corn Borer Invest., 5, 1930, 28 and Ann Inst. Past., 46, 1931, 467, 463 and 469 respectively, presumably the

same as Bacillus pirenei Pospelov, Lenin Acad. Agr. Sci. (U S S.R.), Ann. Rept. 1936, 318-321.) No. 1 from diseased larvae of the corn borer (Pyrausta nubilatis) that hab become black after death; No. 2 from larvae that had become brown; and No. 3 from larvae that had become pinkish-brown

Bacterium radiatum Kern (Kern, Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 438; Bacterium barbatum Migula, Syst. d Bakt., 2, 1900, 317.) From the stomach of a finch.

Bacterium rusticum Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 440) From the stomach of a sparrow.

Bacterum sempervieum Migula. (No NII, Flügge, Ztschr. f. Hyg., 17, 1894, 206; Bactllus lactus No. XII, Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., £, 1896, 269; Migula, Syst. d. Bakt., £, 1900, 321.) From milk

Bacteriumserratum Kern. (Arb. bakt. Inst. Karlsrube, 1, Heft 4, 1896, 451.) From the intestine of a dove.

Bacterium sewerin: Migula. (Sewerin, Cent. f. Bakt., II Abt., 5, 1807, 709; Migula, Syst. d. Bakt., 2, 1900, 330) From manure.

Bactersum spissum Kern. (Arb. bakt. Inst Karlsruhe, 1, Heft 4, 1890, 446.) From the intestine of a bird.

Bacterum sputscola Migula. (Bacillus No 4, Pansini, Arch. f. path. Annt., 122, 1890, 440; Migula, Syst. d. Bak. t. 1900, 306; Bacterium sputs Chester, Man. Determ. Bact., 1901, 190) From sputum.

Bacterum streptococcyforme Migula. (Bacillus thermophilus III, Rabinowitsch, Ztschr. f. 1lyg., 20, 1895, 1895, Miguls, Syst. d. Bakt., z, 1900, 313; Bacterum thermophilum III, Chester, Man. Determ. Bact., 1901, 185) From soil, feces, oron.

Bacterium subdenticulatum Migula. (Bacillus thermophilus VII, Rabinowitsch, Ztacht. f. 11yg, 20, 1895, 158;

Bacterium subrubeum Kern. (Arb. bakt. Inst. Karlsruhe, t, Heft 4, 1896, 450; Bacillus subrubeus Nepvoux, Thèse, Fac. Pharm., Nancy, 1920, 115.) From the intestines of birds.

Bacterium subsquamosum Migula. (Bacterium squamosum longum Kern, Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1806, 458; Migula, Syst. d. Bakt., 2, 1900, 335.) From the intestines of a dove.

Bacterium subthermophilum Migula. (Bacillus thermophilus IV, Rabinowitsch, Ztschr. f. Hyg., 20, 1895, 157; Migula, Syst. d. Bakt., 2, 1900, 344; Bacterium thermophilum IV, Chester, Man. Determ. Bact., 1901, 186.) From soil and feces.

Bacterium subtilis var. galleriae Chorino. (Ann. Inst. Past., 41, 1927, 1120.) From diseased larvae of the bee moth (Galleria mellonclla).

Bacterium tenax Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 443.) From the stomachs of birds.

Bacterium terrae (Ucke) Chester. (Streptobacillus terrac Ucke, Ceat. f. Bakt., I Abt., \$3, 1893, 1001; Chester, Man. Determ Bact, 1901, 199.) From soil.

Batterium truncatum Chester. (Bacillus No. 51, Conn, Storrs Agr. Exp. Sta., 1694, 81; Chester, Man. Determ, Bact., 1901, 195, not Bacterium truncatum Migula, Syst. d. Bakt., 2, 1900, 407; not. Bacterium truncatum Chester, ibid., 167.) From milk.

Bacterium verrucosum Kern. (Arb. bakt. Inst. Karlsruhe, I, Heft 4, 1896, 434.) From the stomachs and intestines of birds.

Bacterium virgula (Duclaux) Migula. 'Tyrothrix virgula Duclaux, Ann. Inst. &at. Agron , 4, 1882, 23; Migula, Syst. d. Bakt., \$, 1990, 323.) From cheese.

Bacterium viride van Tieghem. (Van Tieghem, Bull. Soc Bot France, 1880, 174; Bacillus viridus Trevisan, I generi e le specie delle Batteriacee, 1889, 18) Cellulobacillus mucosus Simola. (Aan. Ac. Sc. Fenn., Ser. A, 34, 1931; abst. in Ceat. f. Bakt., II Abt., 83, 1932, 89.1 Thermophilic; cellulose decomposed quickly at 55° to 60°C, more slowly at 37°C.

Cellulobacillus myzogenes Simola (loc. cit.). Not slimy as above.

Clostridium pelatinosum Laza. (Eine thermophilen Bacillus, Laxa, Cent. f. Bakt., If Abt., 4, 1893, 362; Lava, ibid. 6, 1900, 286; 8, 1902, 154; Bacterium sacchariphilum Migala, Syst. d. Bakt., 2, 1900, 341; Bacterium lazac Chester, Man. Determ. Bact., 1901, 187.) From sugar factory wastes. Produces ellime in sucrose solutions. Probably a variety of Bacillus vulgatus according to Sacchetti (Cent. f. Bakt., II Abt., 28, 1936, 119).

Denitrobacterium thermophilum Ambroz. (Cent. I. Bakt., II Abt., 57, 1913, 3.) From soil.

From sou

Laclobacillus sporogenes Horowits-Whasowa and Nowotelnow. (Cent. f Bakt., II Abt., 87, 1933, 331.) Resembles Laclobacillus delbrueckii but forms ellipsoidal, terminal spores.

Metabacterium polyspora Chatton and Perard. (Compt. rend. Soc. Biol., Paris, 63, 1913, 1232.) The type species of the genus Metabacterium, characterized by forming one to eight spores in a single cell. From the caccum of guines pigs. See Buchanan (Jour. Bact., 3, 1918, 3)]. Myzobacillus betae Connerman. (Ocaterreich-Ungarische Ztechr. i. Zucterind. u. Landwittsch., 35, 1907, 877; see Cent. f. Bakt., II Abt., 21, 1903, 283) Produces slime in sucrose solutions. Appears to be closely related to Bactilus subtitis.

Nitrosobacillus thermophilus Campbell. (Science, 75, 1932, 23.) A thermophile acrobic rod with swollen clavate sporagia; forms nitrites from ammonium salts. From surface layers of soil from North Carolina and Florida.

Semiclostridium commune, S. citreum, S. flavum and S. rubrum Maassen (Arbt. a. d. biol. Abt. f. Land- u. Forstwirtsch. am kaiserl. Ges. Amt., 6, 1907, 1.) Fraduce sline in sucrose solutions.

## Genus II. Clostridium Prazmowski.\*

(Prazmowski, Untersuchungen über die Entwickelungsgeschichte und Fermentwirkung einiger Bacterien-Arten, Inaug. Diss., Leipzig, 1880, 23; Vibrio Müller, Vermium terrestrium et fluviatilum, 1, 1773, 39; Bacterium Ehrenberg, Evertebrata. Berlin, 1828, (8?) \*\*; Metallacter Perty, Zur Kenntniss kleinster Lebensformen, 1852, (180?); Amylobacter Trecul, Compt rend Acad. Sci., Paris, 61, 1865, 435; Bacillus Cohn, Beitr. z. Biol. d. Pflanzen, 1, Heft 2, 1872, 175; Tyrothriz Duclaux, Ann Inst. Nat. Agron., 4, 1882, (797). Pacinia Trevisap, Atti della Accad. Fis. Med. Statist... Milano, Ser. 4, 5, 1885, (837), Cornilia Trevisan, I generi e le specie delle Batteriacee. Milano, 1889, 21: Granulobocter Benerinck, Verhandt, d k. Akad, v. Wetensch., Amsterdam, Tweedie Sect , Deel I, 1893, 4; Bactridium, Paraplectrum, Diplectridium and Plectridium Fischer, Jahrb f Wissensch Botan , 27, 1895, 139, Granulobacillus Schattenfroh and Grassberger, Cent f Bakt, Il Abt, 5, 1890, 702; Streptobacillus Rist and Khoury, Ann. Inst. Past , 16, 1902, 70; Botulobacillus, Butyribacillus, Cellulobacillus, Pulribacillus and Pectobacillus Orla-Jensen, Cent f Bakt., II Abt., 22. 1903. 342-343; Pectinobacter Makrinov, Arch Sci Biol (Russ.), 18, 1915, 442; Bacteroides Castellani and Chalmers, Man, of Trop Med , 3rd ed., 1919, 959; Butyriclostridium and Putriclostridium Orla-Jensen, Jour Bact , 6, 1921, 203; Rivoltillus and Metchnikovillus Heller, Jour Bact , 6, 1921, 550, Omelianskillus, Macintoshillus, Douglasillus, Henrillus, Flemingillus, Vallorillus, Multifermentans, Hiblerillus, Welchillus, Stoddardillus, Arlangillus, Meyerillus, Novillus, Seguinillus, Reglillus, Robertsonillus, Nicollaierillus, Martellillus, Recordillus, Tissierillus, Putrificus, Ermengemilius and Weinbergillus Heller, Jour Bact , 7, 1922, 5-9; Peptoclostridium Donker, Inaug Diss , Delft, 1926, 23 , Botulinus, Chauroea and Welchia Pribram, Jour. Bact , 18, 1929, 374, Angerobacillus, Verrucosus and Euclostridium Janke, Cent. f. Bakt , II Abt , 80, 1930, 490; Bulylobacter Bakonyi, U S Letters Pat , 1,818,782, 1931; Caduceus, Endosporus, Inflabilis, Palmula and Terminosporus Prevot, Ann Inst. Past , 61, 1938, 76-86, Acuformis (syn Palmula) Prévot, Man d Class., etc., 1940, From Greek, elostridium, a little spindle

Rode, frequently enlarged at sportulation, producing clostridial or plectridial forms. The cells possess no entalase. Anaerobic or microaerophilic Biochemically very active Many species ferment carbohydrates producing various acids (frequently including butyric) and gas (CO, II, and sometimes CII,). Others cause rapid putrefaction of prottens producing officasive odors. Commonly found in soil and in human or animal feces. Some species, while growing superphytically on decomposing vegetable matter or on deaf tissue within an animal host, form various toxic and lytic substances and are thereby pathogenic.

The type species is Clostridium buturicum Prazmowski.

Key to the species of genus Clostridium.

- 1 Strictly anaerobic.
  - A Not typically fermenters of cellulose.
    - 1 Do not characteristically produce distinctive pigments.
      - a. Spores central, excentrie, to subterminal.
        - b. Spores oval.
- \* Revised by Prof R. S. Spray, School of Medicine, West Virginia University, Morgantown, West Virginia, November, 1938; further revision May, 1942
- \*\* In a few instances the original records were inaccessible. In such cases the page indicated as (8?). In all other cases the page indicates what is believed to be the earliest record of the designation elited.

- c. Rods distinctly awollen at sporulation.
- d. Motile.
  - e. Gelatin, or glucose gelatin, not liquefied.
    - f. Glucose fermented.
      - g Coagulated albumin not liquefied.
        - Stormy fermentation, or at least active coagulation of milk. Also see hhb.
          - i. Glycerol not fermented.
          - j. Mannitol fermented.
            - k. Starch, lactose and sucrose fermented.
            - Clostridium butyricum.
               kk. Starch not fermented. Lactose and sucrose fermented.
            - la. Clostridium beijerinckii,
          - Mannitol not fermented.
            - k. Starch and lactose not fermented.
          - Clostridium pasteurianum.
             Glycerol fermented.
            - i. Mannitol not fermented.
              - k. Stareh, lactose, sucrose and salicin fermented
        - 1c. Clostridium multifermentans. hh. Milk slowly coagulated; not stormily. Also see hhh
          - i. Glycerol and mannitol not fermented.
            - 2. Clostridium fallax.
          - ii. Glycerol not recorded.
            - j. Acid, hut no gas, from lactose and sucrose.
    - 3. Clostridium fissum. hhh. Milk not coagulated.
      - i. Glycerol not fermented.
    - Clostridium difficile.
       Congulated albumin not recorded.
      - h. Milk acidified, but not congulated.
  - Clostridium viscifaciens.
     Gelatin, or glucose gelatin, liquefied.
    - f. Glucose fermented.
      - g. Congulated albumin not liquefied.
        - h. Milk slowly coagulated. Clot not digested.
          - i. Glycerol and mannitol not fermented.
            - i. Lactose fermented.
              - k. Sucrose not fermented. Salicin fermented.
                6. Clostridium septicum.
              - kk. Sucrose fermented. Salicin not fermented 7. Clostridium feseri.
          - ii. Glycerol fermented.
          - 8. Clostridium hemolyticum.
      - hh. Milk acidified but not coagulated.
        - Glycerol fermented.
          - j. Mannitol not fermented.
             k. Starch fermented Lactose, sucrose and salicin

not fermented Exotoxin formed; toxic on miection but not on feeding. 9. Clostridium nomu

kk Starch not recorded.

! Luctose, sucrose and salicin not fermented m. Adonatol fermented

10. Clostridium botulinum mm Adonttol not fermented.

10a Clostridium botulinum, Type C

gg. Coagulated albumin slowly to rapidly liquefied.

h. Stormy fermentation, or at least active coagulation of milk Clot not digested.

11. Clostridium acelobutylicum.

hh Milk slowly and softly coagulated; not stormily. Clot slowly to rapidly digested

i Glycerol and mannitol not fermented Also see in. 1 Starch not recorded

k Lactose fermented

12 Clostridium aerofoetidum. kk. Lactose not fermented

13 Clostridium sporogenes.

13a Clostridium sporogenes var A P. Marie.

13b Clostridium sporogenes var equine

13c. Clostridium turosinogenes

13d. Clostridium flabelliferum 13e. Clostridium parasporogenes

ii Glycerol fermented Also see iii

i. Mannatol not fermented. 14 Clostridium parabotulinum Types A and B

in. Glycerol not recorded.

1 Manutol and starch not recorded.

k. Lactose and sucrose weakly fermented

1. Gas formed from carbohydrates. 15 Clostridium saccharoluticum

Il Gas not formed from carbohydrates 16 Clostridsum regulare.

ff Glucose not fermented. (Carbohydrates not fermented.)

g Coagulated albumm not digested. Lab-coagulation of ' milk, increasing alkalinity. Clot directed.

17. Clostridium hastiforme.

gg. Congulated albumin not recorded. Slow, mildly neid coagulation of milk. Clot digested.

18. Clostridium subterminale

dd. Non-motile

e. Gelstin, or glucose gelatin, not liquefied 19 Clostridsum malenominatum

cc Rods not swollen at sporulation

- d. Motile.
  - c. Gelatin, or glucose gelatin, liquefied.
    - 1. Glucose fermented.
      - g. Congulated albumin liquefied. Milk slowly congulated Clot slowly digested.
        - 20. Clostridium bifermentans.
    - gg. Coagulated albumin not recorded.
      - h. Milk slowly coagulated; slimy.
        - i. Gas formed from glucose.
        - 21. Clostridium mucosum.
  - ii. Acid but no gas from glucose. 22. Clostridium pruchii.
  - ce. Iron gelatin (Spray), no growth,
- 23. Clostridium cylindrosporum.
- dd. Non-motile. e. Gelatin, or glucose gelatin, liquefied.
  - Glucose fermented.
    - g. Congulated albumin not liquefied,
      - h. Milk stormily fermented. Clot not digested.
        - i. Glycerol fermentation variable.
        - i. Mannitol not fermented. Starch, lactose and sucrose fermented. Salicin rarely fermented. Types identified by specific toxin-satitoria neutralization.
          - 24. Clostridium perfringens Types A. B. C and D.
- bb. Spores erherical.
  - e. Rods distinctly swollen at sporulation.
    - d. Motile.
      - e. Gelatin, or glucose gelatin, not liquefied.
        - f. Glucose fermented.
          - g. Cosgulated albumin not liquefied.
            - h. Milk acidified; slowly and softly coagulated; not stormily. Clot not digested.
              - 25. Clostridium sphenoides.
            - hh. Milk acidified but not coagulated. 26. Clostridium innominatum.
  - cc. Rods not snollen at sporulation.
    - d. Non-motile.
      - e. Gelatin, or glucose gelatin, not liquefied.
        - f. Glucose fermented.
          - g. Coagulated albumin not liquefied.
            - h. Milk acidified but not coagulated. 27. Clostridium filiforme.
- aa. Spores terminal.
  - b. Spores distinctly oval to ellipsoid.
  - c. Rods distinctly swollen at sporulation.
    - d. Motile.
      - e. Gelatin, or glucose gelatin, not liquefied. Also see eee.
        - f. Glucose fermented

- g. Coagulated albumin not liquefied.
- h. Milk slowly coagulated. Clot not digested.
  - i. Glycerol not fermented.
    - j. Mannitol fermented.
      - 23. Clostridium sartagoformum.
  - jj. Mannitol not fermented.
- 29 Clostridium paraputrificum.
- ff. Glucose not fermented
- g. Congulated albuman not liquefied. Milk unchanged. 30 Clostradium cochlearium.
- gg Coagulated albumin not recorded.
- b Milk, or iron-milk (Spray), no growth
  - · Carbobydrates not fermented.
    - j. Ethyl alcohol fermented chiefly to caproic acid.
  - 31 Clostrudium kluyverii.
- 32 Clostridium acidiurici. ce. Gelatin, or glucose gelatin, liquefied. Also see eec.
- f. Glucose fermented
  - g. Coagulated albumin liquefied.
    - h. Milk often, but not always, congulated. Clot, if formed, not digested.
  - 33 Clostridium capitorale.

    bh. Milk acidified but not congulated Slow peptonization.
    - i. Glycerol and mannitol not recorded.
      - i. Starch not fermented.
      - 31 Clostridium parabifermentans.
    - 11. Starch not recorded Lactose weakly fermented.

      35 Clostridium ovalare.
- eee. Gelatin, or glucose gelatin, not recorded. Clucose fermented with acid but no gas. 36 Clostridium zoogleicum.
- bb. Spores spherical, or nearly so
  - c. Rods distinctly swollen at sporulation
    - d. Motile
      - e. Gelatin, or glucose gelatin, not liquefied. Also see ece.
        - f. Glucose fermented.
          - g Congulated albumin not liquefied
            - h. Milk slowly congulated, not stormily. Clot hot digested. Also see hhh.
              - 37 Clostridium thermosaccharolyticum.
          - hh. Milk not congulated, unchanged. Also see hhh.

            3S Clostridium coloritolerans.
          - bbh Milk slowly alkalimized; casein slowly separated.
            39 Closterdium tetanoides.
    - ee. Gelatin, or glucose gelatin, liquefied. Also see eee.
      - 1. Glucose not fermented.

- g. Coagulated albumin slowly liquefied.
  - Milk may show soft lab-coagulation. Clot not definitely digested.
  - 40. Clostridium tetani.
  - hh. Milk shows slow, soft lab-coagulation. Clot slowly digested.
    - 41. Clostridium lentoputrescens.
- ff. Glueose weakly fermented.
  - g. Coagulated albumin slowly liquefied.
    - Milk variably coagulated. Clot, if formed, variably digested.
- 42. Clostridium filamentosum.
- cee. Gelatin records at variance.
  - f. Glucose fermented.
    - g. Coagulated albumin not liquefied.
      - h. Milk not congulated; unchanged.
- 43. Clostridium tetanomorphum.
- dd. Non-motile.
  - e. Gelatin, or glucose gelatin, not liquefied.
     f. Glucose fermented.
    - c. Coagulated albumin not recorded.
    - 44. Clostridium alcaligenes.
  - ee. Gelatin, or glucose gelatin, liquefied.
    - f. Glucose fermented.
      - g. Coagulated albumin not liquefied.
        - 45. Clostridium angulosum.
    - gg. Congulated albumin liquefied.

      46. Clostridium pulrefaciens.
- Characteristically produce pigments of varied colors.
  - a. Spores central, excentric, to subterminal.
    - b. Spores oval.
      - c. Rods distinctly swollen at sporulation.
        - d. Motile.
           e. Gelatin, or glucose gelatin, not liquefied.
          - f Black pigment formed around colonies in deep agar.
            - 47. Clostridium nigrificans.
          - ff. Violet pigment formed in potato mash.
            - g. Indole is formed.
              - 48. Clostridium belfantii.
            - gg. Indole is not formed.
            - 48a. Clostredium maggiorai.
          - fif. Green pigment formed on potato slant.
            - g. Indole is formed 48b. Clostridium derossii.
              - 48c. Clostridium oltolenghii.
              - 48c. Clostridium paglianii.
            - gg. Indole is not formed.

              4Se. Clostrideum lustigii.
              - 48e. Clostridium lustigii 48f. Clostridium sclavoi.

- ffff. Red pigment formed in potato mash.
- g. Indole not recorded.
  - 49. Clostridium venturelli.
- ce. Gelatin, or glucose gelatin, liquefied.
- f. Red to orange-red pigment formed, especially in starchy media.
  - g Indole is not formed.
    - h. Stormy fermentation of milk. Clot slowly softened. 50. Clostridium roseum.
  - hh. Slow, spongy coagulation of malk. Clot slowly digested. 51 Clostridium chromogenes.
  - ff. Yellow-orange pigment formed in various media.
  - c. Indole is not formed
  - h. Milk actively coagulated, not stormily. Clot is not
    - digested 52 Clostridium felsineum
- aa Spores terminal. b. Spores eval.
  - c. Rods distinctly swollen at sporulation.
  - d Non-motile
    - e Gelatin, or glucose getamın, no liquefied
      - f. Deep red pigment formed on potato slants
- 53 Clostridium carbonei. B Typical fermenters of cellulose.
  - 1. Do not characteristically produce distinctive pigments a. Spores terminal.
    - b Spores distinctly oval to ellipsoid
      - c. Rods distinctly swellen at sporulation
        - e. Gelatin, or glucose gelatin, liquefied. Ferments a variety of carbohydrates, other than cellulose, after prolonged cultivation
        - 54 Clostridium spumarum. ec. Gelatin, or glucose gelatin, not recorded Carbohydrates.
        - other than cellulose, not fermented 55 Clastridium werners.
    - bb. Spores spherical, or nearly so.
    - e. Rods distinctly swollen at sporulation d. Non-motile.
      - 56 Clostridium cellulosoli ens
  - 2 Characteristic pigments produced in certain media
    - a Spores terminal. b. Spores distinctly eval to ellipsoid. Rods distinctly swollen at sporulation.
      - 57 Clostridium dissolvens. bb Spores spherical, or nearly so. Rods distinctly swollen at sporulation.
        - 58. Clostridium omelianslii.

 Microaerophilic. Grow customarily as anaerobes, but are able to produce scan sometimes atypical, growth on aerobic agar slaats.

A. Not typically fermenters of cellulose.

1. Do not characteristically produce distinctive pigments.

a. Spores central, excentric, to aubterminal. Spores oval. Rods dis tinctly awollen at aporulation.

59. Clostridium carnis.

ec. Gelatin, or glucose gelatin, liquefied. f. Carbohydrates not fermented.

60. Clostridium histolyticum.

na. Spores terminal. Spores distinctly eval to ellipsoid. Rods distinctly awollen at sporulation.

61. Clostridium tertium.

 Clostridium butyricum Prazmowski. (Untersuch, Q. d. Entwickelungsgeschdigested. ischte u. Fermentwirk, einiger Bacterien-Indole not formed. Arten, Inaug. Diss., Leipzig, 1880, 23;

Bacillus butyricus Flügge, Dio Mikroorg., 2 Aufl., 1886, 296.) From M. L., acidum buturicum, butyrle acid.

Described from the original incom-

plete records of Prazmowski, as amplified by the studies of Adamson, Jour. Patls. and Bact., 22, 1919, 371, and of Hall,

Jour. Inf. Dis., 50, 1922, 467.

Rods: 0.7 by 5.0 to 7 0 microas, straight or slightly curved, with rounded ends, occurring singly, in pairs, in short chains and occasional long filaments. Motile. Spores oval, excentric to aubterminal, swelling rods to clostridial forms. Grampositive, becoming Gram-negative.

Granulose positive in clostridial stage

(blue color with iodine).

Gelatin and glucose gelatin: Not liquefied.

Plain agar slant (anaerobic): Little or no growth.

Glucose agar surface colonies (anaerobie): Circular or slightly irregular, slightly raised, moist, creamy-white.

Deep glucose agar colonies: Biconvex, dense, yellowish-white, entire. Agar fragmented early by abundant gas.

Blood agar not hemolyzed.

Plain broth · Little or no growth. Glucose broth. Abundant, diffuse turbidity; much gas.

Litmus milk: Acid and early coagulation. Litmus is reduced. Stormy fermentation: clot fragmented but not

Nitrites not produced from nitrates.

Fixes atmospheric nitrogen.

Acid and gas from xyloss, glucose, lactose, sucrose, stareb, salicin, esculia and mannitol. Amygdalia, pectin, celulose, glycerol and Ca-lectate not fermented.

Formentation products include butyl, ethyl and iso propyl alcohols, acetone,

organic acids, II, and CO:

Coagulated albumin not liquefied.

Blood serum not liquefied. Brain medium not blackened or di-

gested. Non-pathogenic for guinea pig and

rabbit. Grows well from 30°C to 37°C.

Angerobie.

Source: Originally isolated from cheese. Commonly encountered in naturally soured milk, in naturally fermented starchy plant substances and in soil.

Habitat: Probably rather widely dispersed in soils rich in humus.

Note: Many butyric acid-producing anaerobes are recorded in the literature. The questionable purity and the incomplete descriptions, particularly of the older species, make it difficult to determine the degree of relationship of these apecies to Clostridium butyricum Prazmowski The following list cites the outstanding historic or recently described species.

Ferment butyrique, Pastcur, Compt. rend. Acad. Sci., Paris, 52, 1861, 345 (Vibrion butyrique, Pasteur, ibid , 1261); Bacıllus amulobacter van Tieghem, Bull. de la Soc. Botan. de France, 24, 1877, 128 (Metallacter amylobacter Trevisan, Reale Ist Lombardo d. Sci. c Lett . Rendiconts. 1879, 147; Clostridium amylobacter Holland, Jour. Bact., 5, 1920, 217), Bacterium navicula Reinke and Berthold, Untersucb. a d. Bot. Lab. d. Univ. Göttingen, 1, 1879, 21 (Amylobacter nameula Wehmer, Cent. f. Bakt., II Aht , 4, 1898, 696; Bacillus navicula Chester, Ann. Rept. Del. Col. Agr Exp. Sta , 10, 1893, 128; Clostridium nanculum Prévot, Ann. Inst. Past., 61, 1938, 80); Bacillus butylicus Fitz, Ber. d Deuts Chem Gesellsch , 18, 1882, 867 (Bacterium fitz Buchner, Ztschr. f. Physiol. Chem, 9, 1885, 384); Butylbacillus, Buchner, ibid., 391, Clostridium butyricum (Bacıllus amylobacter) I. II. III, Gruber, Cent. f. Bakt., 1, 1887, 370-371; Bacillus bulylicus Migula, Syst d. Bakt, 2, 1900, 598 (Clostridium butyricum I. Gruber, Cent f. Bakt , 1, 1887, 370), Bacıllus gruberi Migula, loc cit., 599 (Clostridium butyricum II, Gruber, loc cit., 371); Bacillus subanaerobius Migula, loc. cil., 600 (Clostridium butyricum III, Gruber, loc. cit, 371); Bacille amylozyme, also bacille amylocyme, Perdrix, Ann Inst. Past., 8, 1891, 290 (Bacillus amylozyma Migula, Syst. d. Bakt , 2, 1900, 626; Bacillus amylozymicus Peterson, Scott and Thompson, Biochem Ztschr , 219, 1930, 1; Clostridium amylozyme Prévot, Ann. Inst. Pasl, 61, 1938, 79. Clostridium var amylozyme Prévot, Man d. Class , etc , 1910, 109), Bacillus orthobutylicus Grimbert, Ann. Inst Past , 7, 1893, 353, Granulobacter butylicum Beijerinck, Verhandl d K Akad. v Wetensch., Amsterdam, Tweedie Sectic, Deel I, 1893, 3 (Clostridium butylicum Donker, Thesis, Dellt, 1926, 149; Amylobacter butylicum van Beynum and Pette, Cent f Bakt, II Abt, 93.

1935, 200. This species is probably identical with Clostridium butyricum I Gruber, Gent. f. Bakt., I Abt., 1, 1887, 370); Granulobacter saccharobutyricum Beijerinck, loc. cit., 3, also in Arch. Neer-Iand. d Sci. Exactes et Nat., 29, 1896, 1 (commonly identified with Bacillus butylicus Fitz, Ber d Deuts. Chem. Gesellsch., 15, 1882, 867; Bacillus humasus Migula, Syst d Balt . 2, 1900. 600: Clostridium saccharabutyricum Donker. Thesis, Delft, 1926, 147; Amulobacter saccharobutyricus van Beynum and Pette, Cent. f. Bakt., II Abt., 95, 1935, 200); Bacillus saccharobutyricus von Klecks, Cent. f. Bakt , Il Abt , 2, 1896, 169, Bactridium butyricum Chudiakow. Zur Lehre von der Anaeroblose (Russ.), Test I, 1896, (?), cited by Rothert, Cent f. Bakt , II Abt., 4, 1898, 390; Granulobacıllus saccharobutyrıcus mobilis non-liquefactens Schattenfrob and Grasaberger, Gent f Bakt, II Abt., 8, 1899, 702 (bewegliche Buttersaurebacillus, Grassberger and Schattenfroh, Arch. f. Hyg. 42, 1902, 219, Bacıllus saccharobuturious mobilis Hopfie, Ztschr. Infekrakh d Haust., 14, 1913, 396; Bacillus amulobacter mobilis Gratz and Vas, Cent. f Bakt , II Abt , 41, 1914, 509); Plectridium peclinosorum Störmer, Mitteil. d. Deuts. Landnirts. Gesellsch., 18. 1903, 195 (Microbe du rouissage, Winogradsky, Gompt rend Acad. Sci., Paris. 121, 1895, 744, Granulobacter pectinocorum Beijerinck and van Delden, Arch. Néerland d Sci Exactes et Nat., Ser. II. 9, 1904, 423; Clostridium pectinocorum Donker, Thesis, Delft, 1926, 145); Bacillus holabutyricus Perdrix, Compt rend. Soc Biol , Paris, 57, 1904, 481; Bacillus amylobacter Bredemann, Cent. f. Bakt . II Abt . 25, 1909, 385 (Clostridium amylobacter Prévot, Ann Inst. Past., 61, 1938. 79) . Amylobacter nonliquefaciens Ruschmann and Bavendamm, Cent. f. Bakt .. II Abt , 64, 1925, 359; Clostridium intermedium Donker, Thesis, Delft, 1926, 147 (Strain No. 3, Donker, abid., 39); Clostridium bulyrıcum iodophilum

Svattz, Jour. Inf. Dis., 47, 1930, 133 (Clostridium iodophilum Prévot, Ann. Inst. Past., 61, 1938, 80); Granulobacter saccharobulyricus inmobile nonliquefaciens McCoy, Fred, Peterson and Hastings, Jour. Inf. Dis., 46, 1930, 121; Bazillus amylobacter S and IP, Wertheim, U. S. Letters Pat., 1,917,676, 1933; Clostridium tyrobulyricum van Beynum and Pette, Cent. f. Bakt., II Abt., 93, 1935, 208; Clostridium probulyricum van Beynum (Clostridium saccharophilicum and Clostridium saccharophilicum and Clostridium saccharopostulatum Partansky and Henry, Jour Bact., 50, 1935, 564.

1a. Clostridium beijerinckii Donker. (Donker, Thesis, Delft, 1926, 145.) Named for M. W. Beijerinck, the Dutch baeteriologist.

Has the general characters of Clostridium buluricum

Distinctive character: Non-fermenta-

Acid and gas from glucose, lactose, sucrose, inulin, galactose, fructose and mannitol Glycerol and starch not fermented.

Source From soil and fermenting plant tissues.

Habitat Apparently widely distributed in agricultural soils

1h. Clostridium pasteurianum Winogradsky. (Winogradsky, Arch Sci Biol. (Russ.), 8, 1895, 830, Clostridium pastorianum Winogradsky, Cent f Bakt., II Abt., 9, 1902, 43, Bacillus pasteurianus Lehmann and Neumann, Bakt. Dia, tth Aufl., 2, 1907, 82; Bacillus pastorianus Lehmann and Neumann, tbid., 462, not Bacillus pastorianus Macé, Traité Pat. 1 Bact, 4th ed., 1901, 957, Bacillus umogradsky. Weinberg et al., Les Mirobes Annér., 1937, 645) Named for Jouis Pasteur, the French scientist.

Probably related species. Bodily, Univ. Colorado Studies, 26, 1938, 30, records 5 new species isolated from 10 strains received labeled C. pasteurianum. These have been designated as Bacillus dulcito-fermentans, Bacillus rhamnoticus, Bacillus inulofugus, Bacillus nonpentosus and Bacillus azoticus.

Has the general characters of Clostridium butyricum.

Distinctive characters: Prolonged retention of the spore within a peculiar brush-like spore-capsule, and the nonfermentation of starch. Assimilates free atmospheric nitrogen.

Distinguished from Clostridium besjerinckii by the non-fermentation of lactose and mannitol, and from Clostridium butyricum by the non-fermentation of starch.

Acid and gas from glucose, sucrose, inulin, galactose, fructose and dertria. Glycerol, starch, lactose and mannitel not fermented.

Source: Originally isolated from soil. Habitat: Not determined, but apparently of restricted and local distribution in soil.

1c. Clostridium multifermentans Bergey et al. (Bacillus multifermentans tenatbus Stoddard, Lancet, 1, 1912, 12; Multifermentans tenatbus Heller, Journact, 7, 1922, 6; Bergey et al., Manual, lat ed., 1923, 324.) From Latin, multus,

many, and fermentans, fermenting.

Has the general characters of Clostrudium butyricum, and is probably only a variety.

Distinctive character Blood agar colonies show a zone of hemolysis in 24 hours

Nitrites are produced from nitrates
Distinguished from Clostridium butyricum by the above characters and by
the fermentation of glycerol and non-

fermentation of mannitol
Distinguished from Clostridium beijerinckii by the fermentation of starch
and of glycerol.

Distinguished from Clostridium pasteurianum by fermentation of starch and of lactose.

Acid and gas from glucose, fructose, galactose, maltose, lactose, sucrose, raffinose, starch, salicin, inulin and glycerol Mannitol and dulcitol not fermented

Source: Originally isolated from human gascous gangrene.

Habitat: Found in soil and milk Widely distributed in nature

Clostridium fallax (Weinberg and Seguin) Bergey et al. (Bacille A. Weinberg and Seguin, Compt. rend Soc. Biol., Paris, 78, 1915, 277; Bacıllus fallax Weinberg and Seguin, sbid, 686; not Bacillus fallax Ornstein, Ztschr. f Hyg., 91, 1920, 159, Vallorillus fallax Heller, Jour. Bact., 7, 1922, 6, Bergey et al., Manual, 1st ed., 1923, 325 ) From Latin, fallax, deceptive.

Rods. 0 6 by 1 2 to 5 0 microns, occurring singly or rarely in pairs. Motile with peritrichous flagella Encapsulated in body fluids. Spores rarely observed, oval, excentric to subterminal, swelling rods. Gram-positive

Galatin not hauefied

Glucose agar surface colonies (anaerobic): Circular, flat, with transparent,

crenated margin Glucose agar deep colonies Lenticular, bean-shaped, irregular, smooth.

Agar slant (angerobie), Gravish film Broth Poor growth; slight diffuse

turbidity. Glucose broth Abundant turbidity

and gas Clearing by sedimentation Indole not formed (Duffett, Jour

Bact., £9, 1935, 576) Litmus milk: Acid, slowly coagulated Litmus reduced Clot channeled by gas, but not digested

Acid and gas from glucose, galactose, fructose, maltose, lactose, sucrose, mulin, salicin and starch Glycerol and mannitol not fermented Records vary in regard to action on lactose, inclin and

Coagulated albumin not Inquefied

Blood scrum not liquefied Brain medium not blackened or digested.

Meat medium reddened; not blackened or dirested.

Pathogenicity for guinea pig variable, and commonly lost in cultivation Forms a weak evotovin

Optimum temperature not recorded: grows well at 37°C.

Anaerobic.

Source: From war wounds, appendicitis, and once from black-leg of sheep Habitat: Not determined, other than these sources

3. Clostridium fissum (Debono) Bergey et al. (Bacıllus fissus Debono, Cent. f. Bakt., I Abt , Orig., 62, 1912, 232; Bergev et al , Manual, 1st ed , 1923, 332 ) From Latin, fissum, separated

Rods Variable in size, rounded or square ends, occurring singly, in pairs and in chains and filaments. Motile Spores small, eval, subterminal, slightly swelling rods. Gram-positive.

Gelatin · Not liquefied

Deep gelatin colonies at 22°G: Small. brownish, globular, opaque and entire Deep glucose agar colonies: Small, white, globular Gas is formed No

pigment formed. Broth Uniformly turbid Milk: Acid, coagulated after 3 days

Indole not formed. Acid and gas from glucose Acid only

in lactose and sucrose Coagulated albumin not liquefied. Grown at 22°C and 37°C

Angerobic.

Distinctive character All cultures smell strongly of butyric acid

Source From human feces Habitat Not determined, other than

this source

Clostridium difficile (Ilali and O'Toole) Prévot (Bacıllus difficilis Hall and O'Toole, Amer Jour Dia. Child . 49, 1935, 300. Closterdium difficults Prévot, Ann Inst. Past 61, 1938, 84 ) From Latin, difficults, difficult.

Rods: Ileavy-bodied. Actively motile

Spores elongate, subterminal slightly swelling rods. Gram-positive.

Gelatin: Not liquefied.

Blood agar surface colonies (angerobie): Irregular, flat and non-hemolytic.

Deep agar colonies: Minute, flat, opaque disks, becoming lobate.

Milk: Poor growth. Gas formed in traces, but milk unchanged.

Acid and gas from glucose, fructose, mannitol, salicin and xylose. Traces of gas, but no acid, from galactose, maltose, sucrose, lactose, raffinose, inulin and glycerol.

Coagulated albumin not liquefied.

Blood serum not liquefied.

Brain medium with iron is moderately blackened. Digestion not recorded.

Pathogenie for guinea pig and rabbit. Subcutaneous inoculation induces marked edema. Death may occur in from 1 to 9 days.

Toxicity · Glucose broth culture filtrates kill guinea pig and rabbit in 21 to 36 hours.

Grows well at 37°C.

Annerobie.

Source: From feces of new-born infants. Habitat. Not determined, other than this source.

5 Clostridium viscifaciens Sherman and Erb. (U. S. Pat., 2,017,572, 1935.) From Latin, viscus, birdlime, glue; faeiens, making.

Rods: Vegetative cells 3 to 10 microns long; average about 6 microns Motile. Spores oval, 1 by 2 microns, central to subterminal, sometimes swelling rods to club-like and spindle-shaped cells.

Gram-negative.

Granulose reaction positive.

Gelatin: Not liquefied.

Plain agar slant (anaerobie): No growth.

Plain agar stab: No growth.

Liquid media: Tendency toward flocculent growth,

Milk: Acidified but not congulated. Casein not digested.

Corn mash: Not fermented or digested. Indole not formed.

Nitrites produced from nitrates.

Ammonia produced from peptone. Acid, gas and alcohols produced from glucose and maltose.

Acid and gas from sucrose, lactose, devtrin, starch, glycerol, mannitol and salicin.

Caleium lactate: Not fermented.

Fermentation products include butyl alcohol (66 parts), iso-propy) alcohol (31 parts), and small amounts of acctone (3 parts).

Limiting reaction for growth: About pH 4.0 to about pH 8.0.

Optimum temperature 32°C to 36°C. Grows from 15°C to 42 5°G.

Anaerobic.

Distinctive character: In fermentable sugar broths it produces a copious flocculum.

Source: From soil and from grains and other plant materials in contact with soil-Habitat: Apparently widely dispersed

in agricultural soils. 6. Clostridium septicum (Macé) Ford.\* (Vibrion septique, Pastcur and Joubert, Compt. reud. Acad Sci., Paris, 85, 1877, 113, and Bull. Arad Med., 2° Ser., 6, 1877, 794; Vibrio pasteurii Trevisan, Reale 1st. Lombardo d. Sci. e. Lett., Rendiconti, Ser. 2, 12, 1879, 147; Bacillus septicus Macé, Traité Prat. d. Bact., Ist ed., 1888, 455; not Bacillus septicus Migula, Syst. d. Bakt., 2, 1900, 646 [Unnamed aerobic bacillus, Babes, Sept. Proc. d. Kindesalters, Leipzig, 1889, 32; Bacillus septicus ulceris gangraenosi

<sup>\*</sup> Note. In an editorial, Jour. Amer. Vet. Med. Assoc., 62, 1922-23, 565, the name Clostridium septicum is ascribed to Winslow et al., Jour. Bact , 5, 1920, 191. Search fails to confirm the reference Casual mention is not regarded as sufficient to establish priority. Hence, Ford is regarded as the author of this binomial

Sternberg, Man. Bact., 1893, 472); not Bacillus septicus Klein, Micro-organisms and Disease, 1884, 78; Cornilia pasteuri Trevisan, I generi e le specie delle Batteriacee, 1889, 22; Bacillus septicus gangrenge Arloing, Lecons sur la tuberculose et certaines septicémies, Paris, 1892, 451, Vibriogene septique, Rosenthal, Compt rend Soc. Biol., Paris, 64, 1908, 398; Vibrio septique LeBlaye and Guggenheim, Man. Prat. d. Diag. Bact., 1914, 438, Rivoltillus vibrion Heller, Jour Baet . 7. 1922, 6; Bacillus parasarkophysematos Miessner, Cent. f. Bakt , I Abt , Orig , 89 (Bhft.), 1922, 126, and Deuts Tierarztl Wchnschr , 30, 1922, 416 (Bacillus paraearcophysemalos Zeissler, Cent f Bakt. I Aht., Orig., 89 (Bhft ), 1922, 119), Vibrio septicus Rottgardt, Douts Tierarzti Wehnschr., 34, 1926, 553, Ford, Textbook of Bact., 1927, 726, Clostridium septicus Scott, Cornell Vet , 18, 1928, 259, Clostridium septique Topley and Wilson, Princ of Bact, and Immunol . 1st ed . 2. 1929, 1161.) From Orcek, septicus, putrefactive, septic.

Probable synonym: Bacillus of Ghon and Sachs, Cent. f. Bakt, f Abt, Orig, \$4, 1903, 289.

Identical or closely related species Clostridium balaenae Prévot, Ann Inst Past , 61, 1938, 81 (Walfischseptikamie Bacillus, Nielsen, Cent. f. Bakt , 7, 1890, 269. Bacille de la septicémie de la baleine, Christiansen, Compt. rend Soc. Biol , Paris, 83, 1920, 324; Walfischbazullus, Christiansen, Cent. f Bakt, I Abt, Orig , 84, 1920, 127); Bacillus gastromycosis oves Kitt, Bakt. u Path Mikros , 2 Aufl., 1893, 239 (Bradsotbacillus, Nielsen, Monats. Prakt Tierhik, 8, 1897, 59), Bacillus tumefaciens Wilson, Lancet, 196, 1919, 657 (Clostridium tumefaciens Prévot, Ann. Inst. Past , 61, 1938, 81); not Bacillus tumefaciens Israilsky, Cent f. Bakt., Il Abt., 67, 1926, 236; Bacillus seu Clostridium sarcophysematos boois Kitt, Bakterienkunde u Path, Mikros . 2 Aufi., 1893, 232 (Bacillus sarcophyrematos Kitt, ibid., Index, X; not Bacillus sarcophysematos Zeissler, Cent. f. Bakt., I

Abt., Orig , 89 (Bhft.), 1922, 119.) (See Clostridium feseri.)

Confused in the older literature with Koeh's bacillus of malignant edema, Mitt. a d kaus. Gesundhis., 1, 1881, 36 (Bacillus octematis maligni Zopi, Die Spaltpuze, 3 Auf, 1885, 85; Clostratum ockematis malignis Fischer, Jalirb 1. Wissen. Bat., 27, 1895, (1467). Bacillus occiematis Schroeter, in Cohn's Kryptogamen-Fiora v. Schlessen, 3, 1, 1885, 163, Clostridium edematis Holland, Jour. Batt., 5, 1920, 218, Clostradium edematis-maligni florever et al., Manual, 1st ed., 1923, 325).

It is commonly believed at present that Koch's basilius of malignant edema was a culture of Clostridium septicum contaminated with Clostridium approgenes or some closely related organism.

Described from Weinberg and Seguin, La Gang. Gaz, Paris, 1918, 79, and from Hall, Jour Int Dis, 50, 1922, 486.

Rods 06 to 08 by 30 to 80 microns, rounded ends, occurring singly, in pairs and in short chains in cultures, long chains and filaments commonly predominate in body crudates. Motile, with peritrichous fisgella. Spores oval, excentive to subterminal, swelling rods. Gram-positive

Gelatin Liquefied, with gas bubbles. Agar surface colonies (anaerobie): Small, transparent, of variable shape.

Bloodagar surface colonies (anaerobic); Delicate, flat, leaf-like, irregular Hemolytic

Deep agar colonies. Variable, usually finely filamentous, cottony, spherical. Broth Slight, diffuse turbidity, with clearing.

Litmus milk. Litmus reduced, slow congulation and moderate gas Clot not digested.

Indole not formed.
Nitrites produced from nitrates.

Aed and gas from glucose, fructose, galactose, maltose, lactose and salicin. Sucrose, inulin, mannitol and glycyrol not fermented (Hall, for cit, 489).

Congulated albumin not liquefied. Blood serum not liquefied.

Brain medium not blackened or digested.

Meat medium reddened; not blackened or digested.

Pathogenic for guinea pig, rabbit, mouse and pigeon. Forms an evotoxin for which an antitoxin is prepared.

Optimum temperature about 37°C. Anaerobie.

Source: Originally isolated from animals inoculated with soil; later from malignant edema of animals, and from human war nounds and from appendicitis.

Habitat: Animal intestine, and in manured soils.

7. Clostridium feseri Trevisan, (Beweglichen Bakterien, Feser, Ztschr. f. Prakt. Vet.-Wissensch., 4, 1876, 19: Trevisan, Atti Acead. Fis. Med.-Stat. di Milano, 3, 1885, 116; Bactersum chauroei Arloing, Cornevin and Thomas, Le charbon symptomatique du boeuf, Paris, 2nd ed., 1887, 82; Bacillus chauroci De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1004; Bacillus chauraei Trevisan. I generi e le specie delle Batteriocee, 1889, 22; Bacillus fesers Kitt, Bacterienkunde, etc., 2 Aufl., 1893, 233; Bacillus anthracis symptomatici Kruse, in Flugge, Die Mikroorg , 3 Aufl., 2, 1896, 245; Bacıllus carbonis Migula, in Engler and Prantl, Die natur. Pflanzenfam., 1, la, 1895, 26, Butyribacillus chausoei Orla-Jensen, Cent f Bakt., II Abt., 22, 1909, 342; Bacillus gangraenae emphysematosae Hutyra and Marck, Spez. Path. u Ther. d. Haust., 3 Aufl., 1, 1910, 39; Bacillus chauves Holland, Jour. Bact., 5, 1920, 217; Clostridium chaurei Holland, ıbid., 217, Bacıllus anthracis-symptomatici Holland, ibid., 217; Clostridium anthracis-symptomatici Holland, ibid, 217, Bacillus sarkophysematos Miessner, Cent f Bakt., I Abt., Orig., 89 (Bhft ), 1922, 123 (Bacıllus sarcophysematos Zeissler, ibid , 119, not Bacillus sarcophysemotos Kitt, Bakterienkunde, etc., 2 Aufl., 1893, Index, X); Bacillus symptomaticus Matouschek, Cent. f Bakt , II Abt., 58, 1923, 472; Clostridium chauroei Scott, Jour. Inf. Dis., 38, 1926, 262, Clostridium

chauraei Scott, Cornell Vet., 18, 1928, 259.) Named for Feser, an early German bacteriologist.

Possible synonyms: Baeterio ocello cuneato, Rivolta, Giorn. di Anat., Fisiol. e Patol. d. Animali, Piso, 14, 1882, 33, Bacillum cuneatum, Rivolta, ibid, 67, Bacillum ocello-cuncatum, Rivolta, ibid, 67; Bacterium cuneatum Rivolta, ibid, 77: Bacterium ocello cuneatum Rivolta, ibid., 78; Bacillus sarcophysemalosi Peppler, Cent. f. Bakt , I Abt., 29, 1901, 354.

Rods: 1.0 by 3.0 to 8.0 microns, occurring singly, in pairs and in short chains. Usually show a dark chromatic point near each end. Motile with peritrichous flagella Spores oval, excentric to subterminal, swelling rods. Gram positive.

Gelatin: Liquefied. Gas bubbles Agar surface colonies (snaerobic): Small, grayish, semi-opaque, filamentous. Agar slant (anaerobic): Grayish,

spreading growth. Broth: Turbid, slightly peptolytic.

Litmus milk: Acid; slowly coagulated. Gas may be formed. Clot not digested Indole not formed fearly studies record only a trace).

Acid and gas from glucose, fructose, galactose, maltose, lactose and sucrose Inulin, salicin, mannitol, glycerol and dextrin not fermented (Hall, Jour. Inf. Dis., 50, 1922, 486).

Congulated albumin not liquefied. Blood serum not liquefied.

medium not blackened or Brain digested.

Egg-meat medium: Small gas bubbles in 8 hours. Ment becomes pinkish and the liquid slightly turbid. No blackening or digestion.

Pathogesic for guinea pig, mouse and rabbit. Forms an evotovin.

Optimum temperature 37°C. grow at 50°C.

Anacrobic

Source: The cause of black leg, black quarter or symptomatic anthrax in cattle and other animals.

Habitat: Probably soil; especially where heavily manured.

8. Clostridium hemolyticum (Hall) Hauduroy et al (Clostridium hemoluticus bosts Vawter and Records, Jour. Amer Vet Med. Assoc., 68 (N.S 21), 1925-26. 512. Bacillus hemoluticus Hali, Jour Inf. Dis . 45, 1929, 156; Haudurov et al . Diet d. Bact. Path., 1937, 125.) From Greek, haemo, blood; lutieus, dissolving.

Related species: Clostridium hemoluticum var. sordelli Haudurov et al . loc. cit., 126 (Bacillus ap (?), Sordelli, Prado and Ferrari, Compt rend Soe Biol., Paris, 106, 1931, 142; Unnamed anacrobe of Matte, Inst Biol Sec. Nac. Agric., Chile, 2A, 1921, (31?) (ested from Vawter and Records, loc cit., 172)

Rods: 1.0 to 1.3 by 3 0 to 5 6 microns, with rounded ends, occurring singly, in pairs and in short chains Motile with long peritrichous flagella Spores eval to elongate, subterminal, swelling rods.

Gram-positive.

Gelatin: Liquefied.

Blood agar surface colonies (anaerobie). Light, diffuse growth. Blood hemolyzed.

Deep agar colonies: At first lenticular, hecoming densely woolly masses with short peripheral filaments. Little or no gas formed.

Broth plus liver: Luxuriant diffuse turbidity, followed by agglutinative clearing. Moderate gas formed

Milk: Acid and slow coagulation. Clot not digested.

Acid and gas from glucose, fructose, galactose and glycerol. Lactose, maltose, sucrose, raffinose, arabinose, xylose, inulin, salicin, mannitol and dulcitol not fermented. Subsequent studies show that pure galactose is not fermented (Records and Vawter, Nevada Agr. Exp. Sta., Bull 173, 1945, 48 pp.).

Indole is formed.

Methyl red and Voges-Proskauer tests are negative.

Nitrites are not produced from nitrates.

Hydrogen sulfide is produced The four characteristics given above are from Records and Vanter (loc. cst., 30)

Coagulated albumin not liquefied. Blood serum not liquefied.

Brain medium not blackened or directed.

Meat medium reddened, not blackened. No digestion

Pathogeme and toxic for gumea pig and rabbit. Effect due to an unstable hemolytic toxin.

Grows well at 37°C

Angembic

Source From blood and tissues of cattle dying of icterohemoglobinuria

Habitat Not determined. Thus far isolated only from animals.

9 Clostridium novyl (Migula) Bergey et al. (Bacillus oedematis maliani No. 11. Novy, Ztschr f Hyg., 17, 1891, 212; Bacillus oedematis thermophilus Kruse. in Flugge, Die Mikroorg., 3 Aufl., 2, 1896. 242, Bacillus novy: Migula, Syst d. Bakt., 2, 1900, 872. Bacterium ordematis thermophilus Chester, Ann Rept. Del Col. Agr Exp. Sta , 9, 1897, 126, Bacillus thermophilus Chester, Man Determ Bact., 1901, 265, Bacillus oedematiens Weinberg and Seguin, Compt. rend Soc. Biol . Paris, 78, 1915, 507 (Bacille B. Weinberg and Seguin, abid , 177), Novillus maligni Heller, Jour Bact., 7, 1922, 7, Clostridium ordematiens Bergev et al. Manual, 1st ed , 1923, 326; Bergey et al., idem, Clostridium thermophilum Pribram, Jour. Bact , 22, 1931, 439; Clostridium movus Type A. Scott, Turner and Vanter, Proc. 12th Internat. Vet Congr. 2. 1931, 175 ) Named for F. G. Novy, the American bacteriologist who first isolated this organism

Related or possibly identical species: Neuen pathogenen anaeroben Bacillus, Kerry, Osterr. Ztschr f. Wiss. Veterinark . 5, 1894, 228; Barterium nivosum LeBlave and Guegenheim, Man Prat. d. Drag Bact , 1914, 344 (Bacille neigeux, Jungano, Compt. rentl. Sor. Biol., Paris. 62, 1907, 677, Bacillo nevoso, Jungano, 11 Tommasi, 2, 1907, (731?); Gasödembazil. lus, Aschoff, Deuts, med. Webnschr . 42. 1916, 512; Bacillus bellonensis Sacquépée,

Compt. rend. Soc. Biol., Paris, 80, 1917. 850 (Bacille de l'ocdème gazeux malin. Sacquépée, 1bid., 78, 1915, 316; Clostridium bellonensis Prévot, Ann. Inst. Past., 61, 1938, 81); Bacillus gigas Zeissler and Rassfeld, Arch. Wiss. u. Prakt. Tierhlk., 59, 1929, 419 (Clostridium novui Type B, Scott et al., loc. cit., 175; Clostridium gigas Prévot, Ann. Inst. Past., 61, 1938, 82); not Bacillus gigas Trevisan, Atti. d. Accad. Fis. Med. Stat., Milano, Ser. 4, 3, 1885, 96; Clostridium novyi Type C, Scott et al., loc. cit., 175 (nonpathogenic bacillus of ostcomvelitis of buffalo, Kraneveld, Nederl, Ind. Bl. Diergeneesk., 42, 1930, 564; Clostridium bubalorum Prévot, Ann. Inst. Past., 61. 1938, 82; Bacillus osteomyelitis bubalorum Prévot, Man. d. Class., etc., 1940, 123).

Rods 0 8 to 0.0 by 2 5 to 5.0 microns, occurring singly and in pairs, not in chains. Motile with peritrichous flagella. Spores large, oval, subterminal, swelling

rods. Gram-positive.

Gelatin Liquefied and blackened.

Agar surface colonies (anacrobic):

Small, white, with darker center,

filamentous.

Agar slant (anaerobic): Grayish, spreading growth.

Deep agar colonies: Compact, opaque, becoming filamentous with age. Broth. Turbid, with Socculent

sediment.

Litmus milk: Acid, not congulated. Litmus reduced.

Acid and gas from glucose, fructose, maltose, xylose, starch and glycerol. Lactose, sucrose, mannitol, dulcitol, inulin and salicin not fermented (Hall, Jour. Inf Dis, 50, 1922, 491).

C 1 1 11 man and Homefield

digested.

Pathogenic for guinea pig, rabbit, mouse, rat and pigeon. Forms an exotoxin, toxic on injection but not on feeding growth.

Optimum temperature 35°C to 38°C Anaerobic.

Source: From a guinea pig inoculated with peptonized easein; later from gaseous gangrene.

Habitat: Probably occurs in manured soils.

10. Clostridium botulinum (Van Ermengem) Holland. (Bacillus betulinus Van Ermengem, Cent. f. Bakt, 1; Abt., 19, 1896, 443, and Ztschr. f. Hyg, 26, 1897, 48; Holland, Jour. Bact., 5, 1920, 217; Ermengemillus botulunus Heller, Jour. Bact., 7, 1922, 8.) From Latin, botulus, sauusage; M.L., botulinus, relating to sausage.

Clostridium botulinum comprises a number of toxic species, conveniently divided by Bengtson, U. S. Public Health Serv., Hyg. Lab. Bull. 136, 1924, 33, and by Meyer and Gunnison, Jour. Int. Dis. 45, 1929, 90 and 103, and by Gunnison and Advisor of the Comprise of the Com

num) group. Authorities are not yet in agreement on fermentations and on variant sub-types, and the present groupings are only tentative, and subject to revision. Meyer and Gunnison cite some 15 sub-types on the basis of toxicity, agglutination and fermentation.

The original Van Ermengen strain is not available, and his description is inadequate for classification purposes Description follows Bengtson (loc. cl) who used Lister Institute Strain No. 94 (Brit. Med. Res. Counc., Spec. Rept. Ser. No. 12, 1917, 29; ibid., Spec. Rept. Ser. No. 30, 1019, 26) as a type culture

Rods: 0.5 to 0.8 by 3.0 to 8.0 micros, with rounded ends, occurring singly, in pairs and in short to occasional long chains. Motile with peritrichous flagells. Spores oval, central, subterminal, to terminal at maturation, slightly swelling rods. Gram-positive.

Gelatin: Liquefied.

OF

Deep liver agar colonies: Fluffy with dense center.

Liver agar surface colonies (anaerobic). No perceptible growth. Broth: Scant or no growth.

Liver broth · Luxuriant turbidity, with considerable gas.

Milk: Slowly increasing acidity No

coagulation. No gas.

Acid and gas from glucose, fruetore, maltose, devtrin, glyeerol, adonitol and inositol. Galactose, sucrose, lactose, raffinose, inulin, duleitol, mannatol, xylose, arabinose, rbamnose and saliem not fermented (Bengtson, loc. cit, 22-25)

Coagulated albumin not liquefied

Blood serum not liquefied

Brain medium not blackened or

digested.

Meat medium not blackened or

digested
Pathogenic for animals. Forms a

powerful evotoxin which is neurotoxie both on injection and feeding Toxin is neutralized by Clostridium parabolulinum Type B antitoxin.

Optimum temporature 20° to 30°C (Van Ermengem, Ztschr. f. Hyg. 58, 1897, 242); 30°C (Van Ermengem, Arch d Pharmacodyn., 5, 1887, 213 and 499, see Williams and Reed, Jour Inf. Dis, 53, 1926, 193), growth usually earlier at 37°C Toxin production probably best around 28°C.

Anaerobic.

Source: Unknown. Culture received through Reddish from Robertson as Bacillus Sol. 94, Strain A, Institute of Infectious Diseases at Berlin. Similar strains bave been isolated from canned foods.

Habitat: Probably occurs in soil.

10a Clostridum botulinum Type C (Tovin producing anaerole, Bengtson, U. S. Pub Health Repts., 37, 1922, 164 and 2252; Bacillus botulinus Type C, Bengtson, 4bd., 38, and U. S. Pub Health Serv., Hyg. Lab. Bull. 136, 1924, 7, Ctostridium luciliae Bergey et al., Alamual, 1st ed., 1923, 336.) From Latin, botulus, sausage.

Probably identical variety · Clostridium parabotulinum equi Theiler and Robinson, Rev. Gén de Med. Vet., 38, 1927, 199 (Clostridium botulium Type E, Topley and Wilson, Principles of Bact and Immunol, 2nd ed, 11336, 688; Bacillus (Clostridium) botulium D, Weinberg and Ginsbourg, Données Recentes sur les Microbes Andér, Paris, 1927, 107, but shown to be a Type G by Robinson, Union S. Africa, 16th Ann. Rept., Dir. Vet Serv. and Animal Indus, 1930, 125; not Clostridium botulium Type D, Meyer and Gunnison, sude infra). From a rat earenss presumably responsible for botulium n mules in South Africa.

Related varieties. Bacillus parabotulinus Seddon, Jour Comp Path and Therap, 55, 1922, 155 and 275 (Clostridum parabotulinum Ford, Text-Bock of Bact, 1927, 743, 4though this name was used carlier in the "group" senso by Bengtson, U. S. Pub. Health Serv., Hyg. Lab. Bull. 136, 1921, 32). First isolated from bones considered the source of "bulbar parabysis" of cattle in Australia

Cleatridum parabotulnus boris Thelier et al., Uson S. Africa, Dept. Agric., 11th and 12th Repts. of tha Dir. Vet. Educ. and Res., Part II, 1927, 1202 (Cleatridum botulnum Type D, Meyer and Gunnison, Proc See Expt Biol. and Med., 26, 1932-29, S8, 180 Jour. Inf. Dis., 45, 1929, 166; not Cleatridum botulinum Type D, Wernberg and Ginsbourg, side supra). From "lamziekte" of cattle in South Africa.

Clostratum botulinum Type E, Gunnison, Cummings and Meyer, Proc. Soc. Expt. Biol and Med., 55, 1936, 278 An organism received by them from the Russian Ukraine; source of isolation not stated

Clostradium botulinum Type C may be regarded as a variety of Clostridium botulinum, as it has morphologic and cultural characters very similar to those of the Van Ermengem strain. Only divergent or additional characters are recorded here.

Rods: 05 to 0.8 by 30 to 60 microns, commonly alightly curved.

Agar atab: Slight growth. No gas.

Brain medium blackened and digested. Meat medium reddened, then blackened and slowly digested.

Slightly pathogenic far guines pig. Optimum temperature 30°C ta 35°C. Anaerobic.

Source: From gascous gangrene and fram feces.

Habitat: Not determined other than these sources. Probably occurs in soil.

13. Clastridium sparogenes (Metchnikafi) Bergey et al. (Bacillus sporogenes
var. A, Metchnikofi, Ann. Inst. Past., 22,
1903, 944; Bergey et al., Manual, Ist ed.,
1923, 329; not Clostridium sporogenes
Halland, Jour. Bact., 6, 1920, 220 (Bacillus enteritidis sporagenes Klein, Cent. f.
Bakt., I Abt., 18, 1895, 737; Bacillus
sporagenes Migula, Syst. d. Bakt., 2,
1900, 560; Bacillus (enteritidis) sporogenes and Bacillus enteritidis Klein,
Local Gavt. Bd., Ann. Rept. Med. Off.,
Landan, 33, 1903-04, 442 and 443.) From
Greek, sporus, seed; M.L., spore; genes,
producing.

Two varieties, A and B, were described. Bacillus sporogenes var. A, Metchnikof, loc. cit., 944 (Metchnikovillus sporogenes Heller, Jour. Bact., 7, 1922, 9; Clostridium sporogenes var. A, Prévot, Ann. Inst. Past., 61, 1938, 83) is regarded as the typical form and is described here. Var. B, see Clostridium bitermentans.

Synanyms ar probably related species: Ocdembacillen, Koch, Mitt. a. d. kaiserl. Gesundheitsamte, f. 1881, 54; Bacillus ocdematis matigni Zopf, Die Spaltpilte, 3 Aufl., 1885, 88 (not Bacillus ocdematis matigni Liborius, Ztschr. f. Hyg., f. 1888, 188; Bacillus ocdematis Migula, Syst. d. 1884., 2, 1900, 604); Bacillus ocdematis Chester, Man. Determ. Bact., 1901, 292; Clostridium ocdematis matigni Bergey et al., Manual 1st ed., 1923, 325 (see Species

Weigmann, Cent. f. Bakt., Il Aut., E, 1896, 155; Bacillus weigmanni Chester,

Man. Determ. Bact., 1901, 300; Pkctridium foetidum Weigmann, Mykologie der Milch, Leipzig, 1911, 70; Bacillus anaerobius foetidus LeBlaye and Guggenheim, Man. Prat. d. Diag. Bact., 1914, 329; Endosporus foctidus Prévot, Ann. Inst. Past., 61, 1938, 75); Bacillus saprogenes carnis Salus, Arch. f. Hyg., 51, 1904, 114 (Bacillus saprogenes Salus, ibid., 115; not Bacillus saprogenes I, II, III, Herfeldt, Cent. f. Bakt., H Abt., 1, 1895, 77; Bacillus carnis saprogenes Salus, Arch, f. Hyg., 51, 1901, 121; Plectridium saprogenes Prévot, Ann. Inst. Past., 61, 1938, 87); Bacillus sporo. genes coagulans Debono, Cent. I. Bakt., I Abt., Orig., 63, 1912, 229 (Clostridium coagulans Bergev et al., Manual, 1st ed., 1923, 335); Reading Bacillus, Donaldson and Jayce, Lancet, 2, 1917, 448; Bacillus putrificus verrucosus Zeissler, Ztschr. f. Infkrnkh. u. Hyg. Haust., !!, 1920-21. 13 (Bacillus verrucosus Lehmann and Süssmann, in Lehmana and Neumann, Bakt, Diag., 7 Aufl., 2, 1927, 662).

Rods: 0.6 ta 0.8 by 3.0 to 7.0 microns, with rounded ends, occurring singly, in pairs, or less frequently in short ta long chains and filaments. Motile with peritrichous flagella. Spores oval, excentit to subterminal, swelling rods. Grampositive.

Gelatin: Liquefied and blackened.

Agar aurisce colonies (anaerobie); Small, irregular, transparent, becoming opaque, yellowish white, fimbriate.

Deep agar colonies: Woolly balls with dense, nodular center.

Agar slant (anaerobic): Grayish, opaque, spreading.

Blood agar is hemolyzed.

Broth: Turbid. Gas is formed. Putrid odor.

Litmus milk: Softly coagulated. Litmus reduced. Slow peptonization, leaving a dark, amber-colored liquid.

Indole formed (trace). Not formed (Hall, Jour. Inf. Dis., 50, 1922, 482).
Nitrites not produced from nitrates.

Acid and gas from glucose, fructose,

alactose and maltose. Lactose, sucrosc. alicin, glycerol, mannitol and inulia not ermented. (Records vary on many ugars.)

Coagulated albumin liquefied.

Blood serum liquefied to a dark, putrid quid.

Brain medium blackened and digested. oul odor

Meat medium reddened, then blackned and digested with foul odor. Gas is roduced. Tyrosin crystals not obvious.

Non-pathogenic to guines pig and rabat, other than a slight, temporary local umefaction. Filtrate non-toxic on inection and feeding.

Optimum temperature 37°C. Can

row at 50°C

Anaerobic Source. From sutestinal contents. aseous gangrene, and from soil.

Habitat: Common in soil, especially there heavily manured.

The following species are commonly egarded as variants of the typical lostridium sporogenes

13a. Clostridium sporogenes var. A. P. Marie Prévot, Ann Inst. Past., 61, 1938, 3 (Bacille ansémbie, Marie, Compt.

end Soc. Biol., Paris, 95, 1925, 21). Resembles the typical Clostridium porogenes except in the sharp but not

outrid odor of its cultures.

Pathogenicity . Large absccsses are induced on subcutaneous injection into guinea pigs

From spontaneous putrefaction of macerated pork.

13b Clostridium sporogenes var. equine Prévot, Ann Inst. Past., 61, 1938, 83 (Unnamed anaerobe No. IV, Choukévitch, Ann. Inst Past , 25, 1911, 259).

Sporulation is delayed and restricted. Spores are long and almost rectilinear. Litmus milk is coagulated, then the clot is digested after 3 to 4 necks.

Congulated albumin is slowly dissolved.

Not pathogenic for guinea pig or mouse. From large intestine of horse.

13c. Clostridium tyrosinogenes (Hall) Bergey et al. (Culture No. 106, Hall and Finnerud, Proc. Soc. Expt. Biol and Med., 19, 1921-22, 48; Bacıllus tyrosinogenes Hall, Abst. Bact , 6, 1922, 7; not Bacillus tyrosinogenes Rusconi, as cited by Carbone, Ramazotti, Mazzucchi and Monti, Boll, Ist, Sieroter., Milan, 2. 1921, (297), see Clark and Smith, Jour. Bact., 37, 1939, 278; Bergey et al., Manual, 1st ed., 1923, 329; Clostridium aporogenes var. tyrosinogenes Prévot. Aun. Inst. Past., 61, 1938, 83.) From Greek, turus, cheese; M. L., tyrosinum, tyrosine; genes, producing.

Ferments monosaccharides but not bigher carbobydrates (Hall, Jour, Inf. Dis., 30, 1922, 482).

Traces of gas, but no acid, from glycemi, sorbitol, mannose, xylose, lactosc, sucrose, arabinose, galactosc, salicin, inulin, dextrin and starch (F. E. Clark,

personal communication). Distinctive character: Forms large amounts of tyrosin which precipitate in

cultures in protein media. Source · Originally isolated from a culture erroneously labeled Bacillus tetani. Later isolated from an amoutated arm.

Habitat: Not determined. Only two isolations on record.

13d Clostridium flabelliferum Sturges and Reddish. (Fish-tailed putrefactive anaerobe, Reddish and Sturges, Abst. Bact., 8, 1924, 5, Sturges and Reddish, Jour. Baet., 11, 1926, 37; Clostridium sporogenes var. caudapiscis Prévot, Ann. Inst. Past., 61, 1938, 83.) From Latin. flabellum, a little fan; fer, bearing.

Glucose agar surface colonies (anaerobic). Coarse, raised, with long peripheral intertwining outgrowths.

Deep plain agar colonies: Irregular, becoming woolly. Sucrose is fermented (in contrast with

Clostridium aporogenes).

Distinctive character: Spores are long

retained within the sporangium, of which the distal end frays out to fibrils, giving the characteristic fish-tail appearance. Otherwise closely resembles Cloatridium sporogenes.

Source: From source hams and from salt.

Habitat: Not determined, other than these sources.

13c. Clastridium parasporogencs (Bulloch et al.) Bergey et al. (Bacillus Type XII, McIntosh and Fildes, Med. Res. Counc., Spec. Rept. Scr. No. 12, 1917, 36; Bacillus parasporogenes Bulloch et al., Mcd. Res. Counc., Spec. Rept. Scr. No. 39, 1919, 39; Bergey et al., Manual, 1st ed., 1923, 327; Glestridium sporogenes var. parasporogenes Prévot, Ann. Inst. Past., 61, 1933, 83.)

 Deep agar colonies: Lenticular to slightly irregular. Not woolly.

Pathogenic for young guinea pigs. Filtrate non-toxic on injection or on feeding.

Optimum temperature 30°C to 35°C. Distinctive character: Resembles Clostridium sporogenes, but does not form woolly colonies in deep agar, and is agglutinatively distinct Probably merely a variety.

Source : From gaseous gangrene.

Habitat Not determined. Probably occurs in soil.

14. Clostridium parabotullaum Bengtson. (U. S. Pub. Health Serv., Hyg. Lab. Bull. 136, 1924, 32; Types A and B, Burke, Jour Baet , 4, 1919, 556, Clostridium botulnum Types A and B, Berge et al., Manual, 1st ed , 1923, 328.) From Latin, para, like; M.L., botulnum, a species name.

Nore: This group comprises the putrefactive (ovolytic) species, including strains commonly referred to as Memphis and Canton (Type A), and Nevin (Type B). Growth of these types is more easily obtained than with the Clostridium botulinum strains, and the reactions are more obvious. Gunnison and Meyer (Jour. Inf. Dis., 45, 1929, 139) propose an intermediate

a group would provisionally include certain European Type B strains, the Australian Type C, certain American Type C strains, and the South African Type D.

Rods: 0.5 to 0.8 by 3.0 by 8.0 microns, with rounded ends, occurring singly, in pairs, and in short chains. Motile with peritrichous flagella. Spores oral, subterminal, distinctly swelling rods. Gram-positive.

Gelatin: Liquefied.

Deep liver agar colonies: Type A tend to be restricted to compact disks, with sharp outline and small, opaque nucleus at periphery. Type B tend rather to form loose, woolly colonies (indicative only).

Liver agar surface growth (anaerobic).

Profuse, moist.

Broth: Fairly abundant diffuse turbidity. Many strains spontaneously agglutinate.

Liver broth: Luxuriant turbidity.

Profuse gas.

Milk: Slight acidity; slow curdling precipitation, with subsequent digestion and darkening.

Formentation records are vanished Acid and gas from glucose, fructose, detrin, glycerol and salicia Galactose, sucrose, lactose, rhamose, rafinose, inulin, adonitol, ducitol, mannitol, xylose, arabinose and inesitol of fermented (Bengison, loc. cit., 22-25).

Coagulated albumin liquefied: Action of Type B usually more marked than

that of Type A.

Blood scrum liquefied.

Brain medium blackened and digested,
with putrefactive odor.

Meat medium blackened and digested.

Putrefactive odor. Tyrosine crystals not observed.

Pathogeme for animals. Forms a powerful evotoxin which is neurotoxic both on injection and feeding, and which is neutralized only by the homologous type antitoxin.

Optimum temperature : Records at varjance. Grows best at 35 to 37°G. Toxin production best at about 28°G.

Anaerobin.

Distinctive character: Types are identified chiefly by protection tests with known-type antitoxin, and to less exteat by agglutination,

Source. Chiefly from spoiled, non-acid canned goods, from soil and from silage.

Habitat: Found rather widely dispersed in soil.

15 Clostridium saccharolyticum Ber-(Bacillus sporogenes saccharo-Intigus Distaso, Cent. f. Bakt., I Abt., Orig . 59, 1911, 100, Bergey et al., Maaual, 1st ed . 1923. 334 ) From Greek, saccharum, sugar, lyticus, dissolving, digesting.

Rods Short, rounded ends, occurring singly, in pairs and in short chains. Motile Spores large, oval, excentric to subterminal, swelling rods. Gram-posi-

tive Gelatin. Liquefied.

Deep glucose agar colonies. Gray, biconvey, lenticular, granular, eatire. Gas 18 formed

Broth : Turbid.

Milk Soft coagulation; easein precipitated, then pentonized, leaving a clear, vellow-amber supernatant fluid.

Indole is formed.

Acid and gas feebly formed from glucose. Lactose and sucrose feebly, or

doubtfully, fermented. Congulated albumin slowly liquefied. Grows well at 37°C.

Anaerobic.

Distinctive character: All cultures give a mixed butyric and fecal odor.

Source. From feces of a chimpangee Habitat: Not determined, other than this source

16 Clostridium regulare Bergey et al. (Bacillus aporogenes regularia Distaso, Cent. f. Bakt., I Abt , Orig., 53, 1911, 100; Bergey et al., Manual, 1st ed., 1923, 334.) From Latin, straight.

Long rods: With rounded ends, occurring singly and in pairs Motile. Spores oval, small, subterminal, slightly swelling rods Gram-positive.

Gelatin: Liquefied.

Deep agar colonies: Small, opaque, irregular.

Milk: Acid: slowly coagulated, then clot slowly digested.

Indole formed in small quantity. Slight acidity from glucose, lactose and

sucrose. Gas is not formed. Odor of scatol and valerianje acid.

Congulated albumin slowly liquefied. Grows at 37°G.

Anaerobic.

Source. From buman feces.

Habitat: Not determined, other than this source

17. Clostridium bastiforme MacLennan (A4, Gunningham, Cent. f. Bakt., II Abt., 82, 1930-31, 487, and B4a, Cunningham, ibid , 85, 1931, 11; MacLennan, Jour. Path. and Bact , 49, 1939, 513.) From Latin, resembling a spear.

Rods. Sleader, 0 3 to 0 6 by 2 0 to 6 0 microns, with rounded ends, occurring singly, in pairs, and rarely in short chains. Filaments not observed. Motile, with delicate peritrichous flagella, motility persists even after sporulation. Spores elligaidal, subterminal, swelling rods. Polar-cap of protoplasm remains long attached to free spores. Gram-positive

Gelatin: Rapidly liquefied. Blackening not recorded.

Plan agar surface colonies (anaerobic): Minute translucent dots, becoming irregularly round, granular, gravish-white, with onaque center and delicate translucent border.

Blood agar surface colonies (anaerobie): As above, but larger and more oname. Old colonies show gravish pigmentation. No hemolysis.

Deep plain agar colonies : Small , irreoularly round with coarsely filamentous border. A little gas is occasionally formed.

Broth: Transient uniform turbidity, quickly settling as a heavy, white, flocculent deposit. Culture assumes a cheesy odor.

Milk: Abundant growth, with labcoagulation in 2 to 3 days. No increase in activity, incoming slightly alkaline. Clot completely digested in 10 to 14 days, leaving a white, geni-translucent fluid of cheesy oder.

Indole not formed.

Ammonia not formed.

Hydrogen sulfide not formed.

Glucose not fermented.

Carbohydrates not fermented.

Egg medium: No digestion or other visible change

Congulated albumin not digested or blackened.

Blood serum not digested or blackened.

Meat medium not digested or blackened, even in presence of metallic iron.

Meat varticles slightly reddened.

Brain medium not digested or

blackened.

Grows well between 22°C and 37°C.

Anaerobic

Non-pathogenic to guinea pigs on subcutaneous inoculation (Cunningham, Cent f Bakt., II Abt , 83, 1931, 12)

Source Originally isolated by Cananagham as a dissociant from a culture of Bacillus succharbutyricus von Klecki. Later isolated by MacLeman; I stroid from a culture of Clostridium sporogenes, and 2 strains from street dust

Habitat. Not determined, other than these sources.

18 Clostridium subterminale (Hall and Whitehead) comb nor (Boxillus subterminalis Hall and Whitehead, Jour. Inf. Dis., 41, 1927, 66.) Named from the characteristic position of the spores.

Rods Occurring singly, in pairs and rarely in short chains Motile. Spores oval, subterminal, snelling rods. Grampositive Gelatin: Slowly liquefied, with slight turbidity and black sediment.

Blood agar surface colonies (anaerobic): Delicate. At first mildly, later actively, hemolytic.

Deep agar colonies: Opaque, compact, biconvex or lobate dises.

Agar slant (anaerobic): No surface growth.

Glucose broth: Turbidity, but no acid or gas formed,

Indole not formed.

Milk: Slowly coagulated (2 to 3 days), with mild acidity and gas. Slow but complete digestion of casein (8 to 18 days).

Glucose, fructose, galactose, maltose and lactose not fermented.

Brain medium: Slight turbidity in supernatant fluid. Slight gas formation and slow direction.

Iron brain medium: Blackened in 2 to 3 days.

Tyrosin crystals not observable Non-pathogenic to guinea pigs on subcutaneous injection.

Grows well at 37°C.

Obligately anaerobic.

Source: From an African arrowbead. Habitat: Not determined, other than this source.

19. Clostridium matenominatum (Weinberg et al.) comb. nov. (Pseudo-coll anaémbie, Jungano, Compt. rend. Soc. Biol., Paris, 65, 1908-09, 457; Bacillus pseudo-colt anaérobie Jungano and Distiso, Les Anaérobies, 1910, 162; Bacillus pseudocolt anaerobisus LeBlaye and Guggenheim, Man. Prat. d. Ding. Bact., 1914, 315; Bacillus malenominatus Weinberg et al., Les Microbes Anaérobies, 1937, 63; Paraptectrum malenominatum Prévot, Ann. Inst. Past., 61, 1903, 75) From Latin, meaning badly named.

Rods: Short, cocco-bacillary, becoming elongated to short filaments in old cultures—especially in sugar broth. Ends rounded. Distinct bipolar staining tendency. Non-motile. Capsalated, especially in body fluids. Spores oval,

subterminal, slightly swelling rods. Gram-negative.

Gelatin No growth

Deep agar colonies: Small, round, very regular, almost transparent. Gas not formed

Plain brotb: Uniform turbidity, settling after 48 bours, forming a fine, powdery sediment

Indole not produced.

Milk Growth with no congulation

Glucose and sucrose not fermented.

Meat medium: Abundant growth No record of changes. Capsules are demonstrable in this medium.

Very pathogenic for guinea pigs, which die of septicemia in 24 hours after intraperitoneal inoculation. Less pathogenic for rabbit, which dies after one week.

Toxin not demonstrable in cultures Grows at 22°C to 37°C

Obligately anaerobic.
Source From feces of a diarrheal

infant.
Habitat: Not determined, other than

Habitat: Not determined, other than this single isolation.

20. Clostridium bifermentans (Weinberg and Seguin) Bergey et al. (Bacillus bifermentans sporogenes Tussier and Martelly, Ann. Inst. Past., 16, 1902, 894; Bacillus bifermantans Weinberg and Seguin, La Gangrène Gazeuse, Pars, 1918, 128; Martellillus bifermentons Heller, Jour Bact., 7, 1922, 8, Bergey et al., Manual, 1st ed., 1923, 323.) From Latin, bis, twice, and fermentum, a ferment.

Closely related if not identical species. Beaillus centrosprogenes Hall, Jour Inf Dis, 30, 1922, 464 (Clostradum centrosprogenes Bergey et al., Manual, Ist ed., 1923, 322), Bacillus oedematis sporogenes Sordelli, Compt. rend Soc. Biol., Paris, 89, 1923, 55 (Annérobie agent de gangrène gazeuse, Sordelli, viid., 87, 1922, 833, Bacillus sordelli Hall and Scott, Jour Inf Dis, 44, 1927, 329, Bacillus sporogenes oedematis Prening, Thesis, Hanover, 1931, (?), cited from McCoy and McClung, The Anner. Bact., etc. \$2, 1939, 492, Clostridium sordelli Prévot, Ann.

Inst. Past., 61, 1938, 83); Clostridium oedematoides Meleney, Humphreys and Carp, Proc Soc. Expt. Biol and Med., 21, 1998-27, 677.

24, 1926-27, 677.

Varying degrees of virulence and

toxicity occur in the above group. The more toxic and virulent strains are commonly referred to as Bucillus sordelli, although otherwise an apparently homogeneously organized group

Probable synonyms: Clostridium foetidum Liborius, Ztscbr f Hyg , 1, 1886, 160 (Cornilia foctida Trevisan, I generi e le specie delle Batteriacee, 1889, 22, Bacillus foetidus Chester, Ann Rept. Del Col. Agr Exp. Sta., 10, 1898, 128; not Bocillus foetidus Trevisan, loc cil , 16). Bocillus liquefaciens magnus Luderitz. Ztsehr. f. Hyg, 5, 1889, 146 (Cornstia magna Trevisan, loc cit, 22; Bacillus magnus Herfeldt, Cent f Bakt, H Abt , 1, 1895, 78, Bacillus magnus lique facters LeBlave and Guggenheim, Man. Prat d Diag Bact, Paris, 1914, 327, Bacıllus foetidus clostridiiformis LeBlaye and Guggenheim, 1dem, 327), Clostridium foetidum carnis Salus, Arch. f. Hvg. 51. 1904. 121 (Clostridium carnis foetidum and Clostridium foetidum Salus, ibid, 121 and 124; Clostridium carnofoetidus McCrudden, Jour. Biol Chem. 8, 1910-109, Clostridium carnofoetidum Prévot, Ann Inst Past, 61, 1938, 84), Bacillus sporogenes var B, Metchnikoff, Ann. Inst. Past., 22, 1908, 944 (Clostridium sporogenes var. B, Prévot, Ann. Inst Past , 61 , 1938, 83) , Bacillus sporogenes foetidus Choukévitch, Ann Inst. Past , 25, 1911, 257 (Bacıllus foetidus Choukévitch, 261d , 258), Bacillus putrificus tenus Zeissler, Ztschr. f. Infkrnkh. u. Hyg Haust . 21, 1920-21, 13. Bacillus nonfermentans Hall and Whitehead. Jour. Inf. Dis , 41, 1927, 65

Rods 08 to 10 by 50 to 60 microns, occurring singly, in pairs, and in short chains. Sporesoval, central to excentric, not distinctly snelling rods. Motile in very young cultures only (less than 24 hours old) Gram-positive.

Gelatin: Liquefied and blackened.

Agar surface colonies (anaerobie): Circular, crenated to amoeboid.

Bloodagar surface colonies (anaerobie): Small, transparent, hemolytic, becoming opaque, yellowish, spreading.

Broth: Turbidity and gas. Thick mu-

Litmus milk: Slowly congulated. Slowly peptonized, with little cas-

Indole is formed.

Nitrites not produced from nitrates. Hydrogen sulfide is produced. Acid and gas from glucose, fructose.

mannore and maltore. Lactore, sucrose and innlin not fermented. Records suggest variability in glycerol and salicin.

Coagulated albumin rapidly liquefied and blackened.

Blood serum liquefied and blackened. Brain medium digested and blackened.

Figureat medium digested and blackened. Tyrosm crystals in 8 to 10 days. Pathogenicity Variable with the strain; some kill rabbits in 21 hours; others produce only slight edems, while

some shou no effect.
Toxicity . Likewise variable, from acute

to none
Optimum temperature from 30°G to 37°C. Can grow at 50°G.

Anacrobic.

Source. Originally from putrid mest; subsequently from gascous gangrene.

Habitat: Occurs commonly in feecs, soil and sewage. Widely distributed in nature.

21. Clostridium muensum (Klein) Bergey et al. (Bactlus muesus Klein, Cent. Baht., 1 Abt., 29, 1901, 991; not Bacillus muesus Klein, Cent. Unserer Trink- u. Nutzwasser, Chemitz, 2, 1891, 8, Bacterium muesum Migula, Syst. d. Baht., 2, 1900, 315; Bacillus kleini Buchana and Hammer, Iowa Agrie Exp. Sta. Res. Bull. 22, 1915, 276; not Bacillus kleini Migula, Syst. d. Bakt., 2, 1900, 766; not Bacillus kleini Racillus kleini Par Tosi and

Lleinii

Bergey et al., Manual, 1st ed., 1923, 321; Bergey et al., Manual, 4th ed., 1934, 472; not Clostridium mucosum Eimola, cited from Prévot, Man. A. Class, etc., 1910, 112; Endosporus mucosus Prévot, Ann. Inst. Part, 61, 1933, 75.) from Latin, slimy.

Rods: 1.3 by 2.0 to 50 microns, occurring singly, in pairs and in chains. Motille. Spores oval, central, not snelling rods. Gram-negative (Klein, loc. ett.). Young cultures Gram-positive (Buchanan and Hammer, loc. ett.).

Na growth in media without earboby-

Glucose gelatin: Slowly liquefied.
Glucose gelatin surface colonies (anae-

robie): Small, gray.
Glucose gelatin stab; Villous growth.
Slow liquelaction.

Glucose agar slant (anaerobie): Thin, veil-like layer. Slimy condensation water.

Glucose broth: Turbid. Gas bubbles. Litmus milk: Acid; slowly coagulated, slimy. Gas formed. Odor of butyric acid.

Potato: No growth.

Indole not formed.
Nitrites not produced from nitrates.

Acid and gas from glucose. Blood scrum · No gron th.

Non-pathogenic.

Grows at 37°G.

Anaerobic.

Source: Blood sausage (Blutwurst).
Habitat: Not determined, other than
this source.

22. Clostridium pruchii (Buchanan and Hammer) Bergey et al. (Bacillus lactis pruchif Conn. Exten and Stocking, 18th Ann. Rept. Storrs Agric. Exp. Sta., 1906, 179; Bacillus pruchif Buchanan and Hammer, Iowa Agric. Exp. Sta. Res. Bull. No. 22, 1915, 276; Bergey et al., Manual, 1st ed., 1923, 322.) Named for M. J. Pyucha, American bacteriologist.

Rods: Variable in size, with clubshaped ends. Motile, with peritrichous flagella. Spores central, oval, not swelling rods Gram-positive.

Gelatin. Rapid, stratiform liquefaction. Reddish-yellow sediment.

Agar surface colonies (anaerobie): Round flat, white smooth, opaque. Agar slant (anaerobie). Luxuriant,

white, viscid.

Broth Turbid, with focculent pellicle

and gray viscous sediment
Litmus milk · Acid; slowly coagulated,

becoming slimy yellow.

Potato . Thin, brownish, spreading

Indole not formed.

Nitrites not produced from nitrates

Acid but no gas from glucose. Congulated albumin not recorded.

Blood serum not liquefied Non-pathogenic.

Optimum temperature 30°C Grows well between 20°C and 37°C.

Anaerobie Source. From slimy milk.

Habitat: Not determined, other than this source.

23 Clostridium cylindrosporum Barker and Beek (Jour. Biol. Chem, 141, 1941, 3) Named from the characteristic spore morphology

Rods 1 0 by 4 0 to 7.0 microns, atraight. Mottle with peritrichous flagella Spores clongate to cylindrical, 1 0 to 1.1 by 1.7 to 3 0 microns, central, subterminal to terminal, with little or no swelling of rods Gram-negative.

Iron-gelatin (Spray). No growth.

Deep plain agar. No growth.

Deep uric acid agar colonies. Whitish, compact, lobate, I to 2 mm in diameter, with irregular edges, surrounded by a

zone of precipitated ammonium ureate which gradually disappears.

Plain broth: No growth.
Glucose broth: No growth.

Iron-milk (Spray): No growth.

Indole not recorded (probably negative).

Nitrites not recorded (probably negative).

Glucose not fermented.

Carbohydrates not fermented Cellulose not fermented.

Coagulated albumin not liquefied.

Blood serum not liquefied.

Broin medium not digested or blackened.

Pathogenicity not recorded (probably non-pathogenie)

Optimum temperature about 35°C. Optimum reaction about pH 7.5; lower limit for growth pH 6 5.

Anserobie. Distinctive characters: Requires uric acid, or certain other purmos, as a primary source of carbon and energy. The purines are converted into ammonia, CO<sub>4</sub>, acette acid and a little glyene. This organism is physiologically similar to Clostradium acidi-urice, but may be readily distinguished from the latter by

its morphology.

Source. A single strain isolated from soil

Habitat Probably soil, although only this single isolation is recorded.

24. Clostridium perfringens (Veillon and Zuber) Holland.\* Clostridium perfringens Type A, Wilsdon (Bacilius aerogenes capsulatus Welch and Nuttall, Johns Hopkins Hopp, Bull 5, 1822, 81 (Bacilius capsulatus aerogenes Lehmann and Neumann, Baht. Diag, 2 Aufl. 2, 1899, 337), Bacilius pilepmanes enphysematosos Fraenkel, Ueber Gasphleg.

<sup>\*</sup>Because of use of the species name perfinquest by the Permanent Standards Commission of the Health Organization of the League of Nations (Report of the Permanent Commission on Biological Standardization, London, June 23, 1931), the use of this name has been continued although it is preceded by a valid binomial (Bacillus emphysemolosus Kruse).

monen, Leipzig, 1893, 47; Bacillus emphysematosus Kruse, in Flügge, Die Mikroorg., 3 Aufl., 2, 1896, 242; Bacterium aerogenes capsulatus Chester. Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 125; Bacterium emphysematosus Chester, 1bid., 126; Bacıllus emphysematis vaginac Lindonthal, Wien. Llin. Wehnschr., 10, 1897, 42; Bacillus perfringens Veillon and Zuber, Arch. Med. Expt. ct Anat. Path., 10, 1898, 539; Bacillus capsulatus anaerobius and Bacillus capsulatus aerogenes Binaghi, Cent. f. Bakt., II Abt., 4, 1898, 920; Granulobacillus aaccharobutyricus immobilis liquefaciens Schattenfroh and Grassberger, Cent. f. Bakt., II Abt., 5, 1899, 702 (Granulobacillus immobilis Schattenfroh and Grassberger, Arch. f. Hyg., 37, 1900, 68, Bacillus amylobacter immobilis Gratz and Vns. Cent f. Bakt . II Abt .. 41, 1914, 509), Bacterium welchii Migula, ıbıd., 392; Bacıllus welchii Lehmann and Neumann, Bakt Ding, 4 Aufl., 2, 1907, 457; Bacillus butyricus asporogenes immobilis Rocchi, Cent f. Bakt., I Abt., Orig., 60, 1911, 580, probably Bacillus multiformse Distaso, Cent. f Bakt., I Abt , Orig , 69, 1911, 101 (Bacteroides multiformis Bergey et al , Manual, 1st ed., 1923, 263, Cillobacterium multiforme Prévot, Ann. Inst Past , 60, 1938, 297; not Bacillus multiformis van Senus, Inaug. Diss., Leiden, 1890, (?), quoted from Herfeldt, Cent. f Bakt., H Abt, 1, 1895, 117); Bacillus aerogenes-eapsulatus Holland, Jour Bact., 5, 1920, 217, Clostridium acrogenes-capsulatum Holland, ibid , 217, Bacillus phlegmonesemphysematosae Holland, 1814, 219; Clostridium phlegmones emphysematorae Holland, ibid , 219; Clostridium phlegmones emphysematosae Holland, shid., 222; Clostridium welchis Holland, ibid., 221, Clostridium perfringens Holland, abid., 219; Welchillus aerogenes Heller, Jour. Bact., 7, 1922, 6; Butyribacillus ammobilis-liquefaciens Heller, ibid., 18; Bacillus welchii Type A Wilsdon, Univ. Cambridge, Inst. Animal Path., 2nd Rept. of Dir., 1931, 72, Clostridium

saccharobutyricum liquefaciens van Bey. num and Pette, Cent. f. Bakt., II Abt . 93, 1935-36, 205; Welchia perfringens Prévot, Ann. Inst. Past., 61, 1938, 78.) Latinized, very fringed

Related varieties: Clostridium egens Bergey et al., Manual 1st ed., 1923, 324 (Bacillus egens Stoddard, Jour. Exp. Med., 29, 1919, 187; Stoddardillus egens Heller, Jour. Bact., 7, 1922, 6; Clostridium perfringens var. egens Hauduroy et al . Dict. d. Baet. Path., 1937, 124; Welchia perfringens var. egens Prévot, Ann. Inst. Past., 61, 1938, 78).

Clostridium perfringens Type B. Wilsdon. (Bacillus of lamb dysentery, Dalling, Jour. Path, and Bact., 28, 1925, 536, and ibid., 29, 1926, 316; L D. Bacillus, Dalling, Handbook Ann. Congr. Nat Vet. Med. Assoc., Gt. Britaia and Ireland, 1928, 56; Bacillus welchii Type B, Wilsdon, Univ. Cambridge, Inst Animal Path., 2nd Rept. of Dir., 1931, 73; Clostridium welchii (Type agni) Glenny et al , Jour. Path. and Bact., 57, 1933, 53; Bacillus agni Weinberg et al., Les Mic. Annér., 1937, 233; Welchia agni Prévot, Ann. Inst Past., 61, 1938, 78.)

Clostridium perfringens Type C, Wilsdoa. (Bacillus paludis McEnen, Jour. Compar. Path, and Ther, 43, 1930, 1; Bacillus welchis Type C, Wilsdon, Univ. Cambridge, Inst Animal Path, 2nd Rept of Dir , 1931, 73; Welchia agni var. paludis Prévot, Ann Inst. Past, 61, 1938, 78; Welchra paludis Prévot, Man d. Class . etc., 1910, 217.)

Clostridium perfringens Type D, Wilsdon. (Bacillus welcht: Type D, Wilsdon, Univ. Cambridge, Inst. Animal Path., 2ad Rept. of Dir., 1931, 74; Bacellus oritoricus Bennetts, Austral. Inst. Sei. and Indus , Bull. No. 57, 1932, 5, and Vet. Jour., 88, 1932, 250; Welchia agni var ordoxicus Prevot, Ann Inst Past, 81,

## 217.)

Probably related (or possibly identical) rhumatisme, varieties: Bacille ฮน

Achalme, Compt. rend. Soc. Biol., Paris. 45, 1891, 651, and Ann. Inst. Past., 11, 1897, 848 (Bacille and bacterium d'Achalme, Thiroloix, Compt. rend. Soc. Biol . Paris. 49, 1897, 268, Bacillus achalmes Neveu-Lemaire, Précis Parasitol. Hum , 5th ed , 1921, 24); Baeillus emphysematis maligni Wieklein, Arch. f. Path Anat u. Physiol , 125, 1891, 91, Bacillus cadateris Sternberg, Researches relating to the etiology and prevention of yellow fever, Washington, 1891, 212 (Bacterium cadareris Migula, Syst d. Bakt . 2. 1900, 510, not Bacillus cadareris Klein, Cent. f. Bakt., I Abt , 25, 1899, 279, not Clastridium cadaveris Sternberg. loc cit, 213; not Bacillus cadareris Migula, loc cit., 646); Bacillus cadaveris buturious Buday, Cent f Bakt, I Abt, 24, 1898, 374 (Bacillus budays and Bacterium cadaieris butyricum LeBlaye and Guggenheim, Man. Prat de Diag Bact., 1914, 378, Eubacterium cadaveris Prévot, Ann Inst Past., 60, 1938, 295).

Ann Inst Past., 60, 1933, 295).

Bacillus zoodysenteriae Weinberg et al,
Les Mic. Anaer, 1937, 256 (Bacillus
zoodysenteriae hungaricus Detre, Cent f
Bakt, I Abt., Orig., 104, 1927, 251,
Welchia perfringens var. zoodysenteriae

Prévot, Ann Inst. Past , 61, 1938, 78)
Clostridium perfringens var. anaerogenes Hauduroy et al., Dict d. Bact.
Path , 1937, 122 (Unnamed species of
Grootten, Compt. rend Soc Biol , Paris,

100, 1929, 499).
Rods Short, thick, 10 to 15 by 40 to 80 microns, occurring singly and in pairs, less frequently in short chains. Non-motile Sporesoval, central to excentrie, not swelling rods. Encapsulated Grampositive

Gelatin Liquefied and blackened Agar surface colonies (anaerobie). Circular, moist, slightly raised, opaque

center, entire

Broth: Turbid; peptolytic. Clearing
with viscid sediment.

Litmus milk Acid, coagulated. Clot torn with profuse gas formation, but not directed. Potato: Thin, grayish-white streak; gas in subtended liquid.

Indole not formed.

Nitrates produced from nitrates.

Acid and gas from glucose, fructose,

galactose, mannose, maltose, lactose, sucrose, xylose, trehalose, rafinose, starch, glycogen and inositol. Mannitol mot fermented. Salicin rarely fermented. Action on inulin and glycerol variable

Coagulated albumin not liquefied.

Blood serum not liquefied

Brain medium not blackened or digested.

Egg-meat: Profuse gas production in 8 hours. The meat is reddened and the liquid becomes turbid. No digestion.

Pathogenic for guinea pig, pigeon and mouse. Produces an exotoxin for which an antitoxin can be prepared.

Optimum temperature 35°C to 37°C. Can grow at 50°C.

Anaerobic.

Distinctive characters. Stormy fermentation of milk, combined with nonmotility.

Source: Gaseous gangrene, feces, milk and soil.

Habitat: Widely distributed in feces, sewage and soil.

25 Clostridium sphenoides (Bulloch et al) Bergey et al (Bacillus sphenoides Bulloch, Bulloch, Douglas, Henry, McIntosh, O'Brien, Robertson and Wolf, Med Res Coune, Spec Rept Ser. No. 39, 1919, 48, Desuglasillus sphenoides Heller, Jour Baet, 7, 1922, 5; Bergey et al, Manual, 1st ed., 1923, 331; Plectridium sphenoides Prévot, Ann. Inst., Past., 61, 1933, 88) From Greek, wedge-shaped.

Described from Bulloch et al , loc. cit , as amplified by Hall, Jour. Inf. Dis., 30, 1922, 502.

Rods: Small, fusiform in vegetative state, occurring singly, in pairs and occasionally in short chains. Sportulating cells cuncate. Motile. Spores spherical, subterminal, becoming terminal on maturation, swelling rods. Gram-positive only in young cultures.

Gelatin: Not liquefied.

Agar surface colonies (anaerobie): Circular, or slightly irregular, entire.

Blood agar surface colonies (anaerobic): Minute dew-drops, becoming whitish. opaque. Blood is bemolyzed.

Deep agar colonies: Minute, opaque. smooth disks.

Broth: Turbid.

Litmus milk: Acid; slowly and softly congulated. Clot not digested.

Indole not formed (indole formed by Tholby strain, Stanley and Spray, Jour. Bact., 41, 1941, 256).

Nitrites produced from nitrates.

Acid and gas from glucose, galactose, maltose, lactoso and salicin. Joulin. glycerol and dulcitol not fermented. Strains are apparently variable on mannitol, sucrose, dextrin and starch.

Congulated albumin not liquefied.

Blood serum not liquefied. Brain medium not blackened or di-

gested. Non-pathogenic for guinea pig and

rabbit.

Optimum temperature not determined. Grown well at 30°C to 37°C

Anaerobie.

Source. From gangrenous war wounds. Habitat: Not determined, other than this source

26. Clostridium innomiastum Prévot. (Bacillus E, Adamson, Jour. Path. and Bact., 22, 1918-19, 391; Prévot, Ann Inst. Past., 61, 1938, 85 ) From Latin, remaining unnamed

Rods: Very small, thick, tapering at one or both ends, occurring singly, paired, in chains and filaments. Involution forms abundant on glucose agar. Motile. Spores small, spherical, subternmal, swelling rods Gram-positive, quickly becoming Gram-negative.

Gelatin: Not liquefied.

Glucose agar surface colonies (annerobie): Two forms are produced: 1) Gircular, entire edge, opaque; 2) Diffuse, spreading, irregular and translucent.

Plain agar surface colonies (anaerobic): Small, circular, entire edge, whitishtranslucent, becoming opaque-yellowish with age.

Plain broth: Moderate turbidity, clearing by sedimentation in 3 to 4 days.

Glucose broth: More abundant turbidity and slight gas production.

Milk: Slowly acidified but not clotted. No further change.

Glucese, maltose, lactose and mannitol fermented with acid and gas.

Sucrose not fermented. Congulated albumin: Not digested or

blackened. Meat medium: Not digested or black-

ened. Blood scrum: Not digested or black-

ened. Brain medium: Not digested or black-

ened. Noa-pathogenic (Prévot, loc. cit.).

Grous well at 37°C.

Angerobic. Source: From septic and gangrenous war nounds.

Habitat: Not determined, other than this source.

27. Clostridium filiforme Bergey et al. (Bacıllus regularis filiformis Debono, Cent. f. Bakt., I Abt., Orig., 62, 1912, 231; Bergey et al., Manual, 1st ed., 1923, 331.) From Latin, thread-like.

Rods: 0 5 to 0.8 by 3.0 to 5.0 microns, slender, occurring singly, in pairs, in and filaments. Non-motile. chains Spores very small, spherical, subterminal, or occasionally terminal, not swelling rods. Gram-positive.

Gelatin: Not liquefied.

Deep gelatin colonies: Small, gray, filamentous.

Deep agar colonies: Irregular, gray, translucent, filamentous

Broth: Uniform turbidity.

Litmus milk. Acid, but no further change.

Potato: Cray, filamentous; substance not digested.

Acid and gas from glucose and lactose Acid only from sucrose and dulcitol. Starch not fermented.

Congulated albumin not liquefied Grows in gelatin at 22°C.

Anacrobic.

Source · From human feces. Habitat. Not determined, other than this source

28 Clostridium sartagoformum Partansky and Henry. (Jour. Bact., 39, 1935, 570.) From Latin, shaped like a frying-pan.

Rods 0.3 to 0 5 by 3.5 to 6 0 microns. Slender, curved, with rounded ends, occurring singly Motile. Spores eval, terminal, swelling rods Cram-positive.

Gelatin · Not liquefied.

Agar surface colonies (anaerobic) Convex, discrete, circular, transparent to white and opaque. Surface moist and smooth.

Blood agar not hemolyzed.

Deep agar colonies · Regular, lenticular, smooth

Broth · Clear; no growth.

Glucose broth: Turbid, with gas bub-Litmus milk. Acid; slowly coagulated.

with some ras formation. Clot not digested Potato: Very scant growth No gas in

surrounding liquid.

Indole not formed.

Nitrites not produced from nitrates. Acid and gas from xylose, glucose, fruetose, galactose, sucrose, lactose, maltose, raffinose, inulin, salicin, mannitol, acetate and but vrate Starch, ethanol, glvcerol and dulcitol not fermented.

Coagulated albumin not liquefied. Blood serum not liquefied. Scant growth.

Brain medium not blackened or digested Some gas is formed. Optimum temperature 37°C

Anaembic.

Distinctive character: Ferments sulfite

waste liquor in 40 per cent concentration, forming butyric and acetic acids, II: and CO:.

Source: From garden soil and from stream and lake mud.

Habitat: Not recorded; obviously soil. Distribution undetermined

29. Clostrldlum paraputrificum (Bienstock) Snyder. (Art V. Bienstock, Fortschr. d. Med., 1, 1883, 612; Bacillus diapthirus Trevisan, I generi e le specie delle Batteriacec, 1889, 15; Bacıllus paraputrificus Bienstock, Ann. Inst Past., 20, 1906, 413, and Strassburger Med. Zeit., 3, 1906, 111; Bacillus paraputrificus coli Henry, Brit. Med. Jour , 1, 1917, 763; Trasferillus paraputrificus Heller, Jour, Bact., 7, 1922, 27; Snyder, Jour. Bact., 32, 1936, 401; Plectridium paraputrificum Prévot, Man. d. Class., etc., 1940, 160.) From Latin, also putrefying.

Probable synonyms: Kopichenbakterien, Escherich, Fortschr. d. Med , 8, 1885, 515, Bacillus No. 3, Rodella, Ztschr. f Hyg., 59, 1902, 209 (Plectridium fluzum Prévot, Ann. Inst. Past., 61, 1938, 87); Art XI, Hibler, Cent. f. Bakt., I Abt., 25, 1899, 516 (Art IX, Hibler, Untersuch, u. d Path Anser., 1908, 3 and 407; Plectridium nonum Prévot, Ann. Inst. Past., 61, 1938, 88); Anacrobe b, Dalyell, Jour Path. and Bact., 19, 1914-15, 281; Bacillus annutratus Kleinschmidt, Monatschr. f. Kinderheilkunde, 62, 1934, 18 (Palmula innutrita Prévot, Ann. Inst. Past., 61, 1938, 89; Acuformis innutritus Prévot, Man d Class, etc., 1940, 165).

Described from Hall and Snyder, Jour.

Bact., 28, 1934, 181 Rods. 03 to 05 by 20 to 60 microns.

Straight or slightly curved, single, in pairs, or in short chains. Ends rounded. Motile with peritrichous flagella. Spores oval, terminal, swelling rods, Grammositive.

Gelatin: Not liquefied. Gas is formed. Blood agar surface colonies (anaerobie): Delicate, irregular, round topped dowdrops. Non-hemolytic.

Deep agar colonies: Small, irregular, opaque, dense, cottony masses. Gas is formed.

Broth : Diffuse turbidity.

Milk: Usually congulated in from 6 to 10 days. Abundant gas, but no peptonization.

Indole is not formed.

Acid and gas from glucose, fructose,

gested. Non-proteolytic.

Non-pathogenic for guinea pig and rabbit.

· .. francastad

Grons well at 37°C.

Anaerobie.

Source · Feces, gaseous gangrene, and postmortem fluid and tissue cultures.

Habitat: Undetermined, other than these sources. Evidently occurs commonly in intestinal canal of human beings.

30. Clostridium coehlearium (Bulloch
"""" Type IIIe,
"""" pec. Rept.

ochlearius

Bulloch, Bulloch, Douglas, Henry, McIntosh, O'Brien, Robertson and Wolf, Med. Res. Counc., Spec. Rept. Ser No 39, 1919,

ium Prévot, Ann. Inst Past, 61, 1938, 88; Plectridium incertum Prévot, idem.) From Latin, spoon-shaped.

Rods: Slender, straight, occurring chiefly singly, or infrequently in pairs and in short chains. Motile with peritrichous fingella. Spores oval, terminal, swelling rods. Weakly Gram-positive.

Gelatin . Not liquefied.

Agar surface colonics (anaerobic). Circular, clear, entire, or with cremated edge.

Deep agar colonies. Lenticular, entire Broth: Turbid. Litmus milk: Unchanged. Glucose not fermented.

Carbohydrates not fermented. Cozgulated albumin not liquefied.

Blood scrum not liquefied.

Brain medium not blackened or digested.

Meat medium: Slightly reddened. Not blackened or digested. Little gas of nonputrefactive odor.

Non-pathogenic.

Optimum temperature 30°C to 35°C.

Source: From human war wounds and septic infections.

Habitat: Not determined, other than these sources. Probably occurs in soil.

31. Clostridium kluyveri Barker and Taha. (Jour. Baet., 45, 1942, 347.) Named for A. J. Kluyver, in whose laboratory the organism was discovered.

Rods: 0 9 to 1.1 by 3.0 to 11.0 microns. Straight to slightly curved; usually single, but also paired and occasionally in long chains. Motile with peritrichous flagella. Spores oval, terminal, swelling rods. Generally Gram-negative; some strains weakly Gram-positive when young.

Young.

Iron-gelatin (Spray): No growth.

Surface agar colonies (anaerobic): Growth slow and restricted by residual traces of oxygen. Rough and smooth colonies are produced.

Deep agar colonies (yeast autolysate and Call(OII): Small colonies (1 to 3 mm) after 2 to 3 days; two types are formed: a) fluffy spheres with dense nuclear conter and filamentous periphery; b) compact, lenticular colonies. Little cas is formed.

Plain broth: No growth.

Glucose broth: No growth.

Milk or iron-milk (Spray): No growth. Indole not recorded (probably nega-

tive).

Nitrites not recorded (probably negative).

Glucose not fermented.

Carbohydrates not fermented.

Cellulose not fermented. Congulated albumin not liquefied.

Congulated albumin not liqueled Blood serum not liqueled.

Brain medium not digested or blackened.

Probably non-pathogenic.

Optimum temperature about 34°C. Grows between 19°C and 37°C.

Optimum reaction about pH 68. Range for growth pH 60 to 7.5.

Anaerobic.

Distinctive characters: Large size of cells, and slow growth, accompanied by non-putrefactive odor of caprole and and of higher alcohols. Growth is exceptionally favored by synergistic association with Methanobacterium omelianskii. In pure cultures high concentration of yeast autolysate is required. Caprole need is formed from ethyl alcohol.

Source. From black mud of fresh water

and marine origin

Habitat: Not determined, other than these sources. Evidently widely dispersed in nature

32. Clostridium acidiurici (Liebert) Barker. (Bacillus acidi urici Liebert, Koninkl Akad. v Wetensch., Proc. Sect. Sci., Amsterdam, 15, 1909, 55; Barker, Jour Bact, 58, 1938, 323.) Named from its characteristic ability to forment uric acid

Rods 0 5 to 0 7 by 2 5 to 4 0 microns, straight Motile with peritrichous flagella Spores oval, terminal, awelling rods. Most strains Gram-negative. A few strains weakly Gram-positive, quickly becoming Gram-negative.

ickly becoming Gram-negative. Iron-gelatin (Spray): No growth.

Deep plain agar : No growth.

Deep uric acid agar colonies. Whitish, compact, lobate, 1 to 2 mm in diameter, with irregular edge, surrounded by a temporary zone of precipitated ammonium ureate which gradually diseppears.

Surface uric acid agar colonies (anaerobic): Variable with strain and with moisture of medium. Colonies 1 to 2 mm in diameter, opaque, white, raised, round, smooth edge, with concentric aurience markings, and of rubbery consistency. Other colonics may be very thin, soft, transparent, with fimbriate projections, apreading to cover almost the entire plate. Intermediate colony types also observed.

Plain broth: No growth.
Glucose broth: No growth
Iron-milk (Spray): No growth.
Indole not recorded (probably negative)

Nitrites not recorded (probably negative).

Glucose not fermented.
Carbohydrates not fermented.
Cellulose not fermented.
Ceagulated albumin not liquefied.
Blood serum not liquefied.
Brain medium not digested or black-

ened
Probably non-pathogenic.
Optimum temperature about 35°C.
Optimum reaction about pH 7.5; lower

limit for growth about pH 6 5.

Anaerobic.

Distinctive characters: Requires uric acid, or certain other purines, as a primary source of carbon and energy. The purines are converted mainly into ammonia, CO, and acetic acid. During growth the medium tends to become alkahne (pH 80 to 85); there is no visible evolution of gas

Source From soils of diverse origin Habitat. Evidently widely dispersed in soils Present in fecal material of yellow-shafted flicker (Colaptes auratus).

33 Clostridium capitovale (Snyder and Hall) Snyder (Bacillus capitovalt Snyder and Hall, Cent f. Bakt., I Aht., Orig, 155, 1933, 290, Clostridium capitovalts Snyder, Jour. Bact., \$2, 1936, 401; Plectridium capitovalis Prévot, Ana. Inst. Past., \$0, 1938, 87.) From Latin, oval-headed.

Rods. 0 5 to 0 8 by 2 0 to 2 5 microns. Stender, commonly curved, with rounded ends, occurring singly, in pairs, and rarely in short chains. Motile with long peritrichous flagella. Spores oval, terminal, an elling rods. Gram-positive.

Gelatin: Liquefied.

Blood agar surface colonies (anaerohie): Tiny, transparent, round or irregular dew-drops, becoming opaque. Non-hemolytic,

Deep agar colonies: Small, apaque. lenticular to heart-shaped.

Tryptone broth: Turbid. Gas is formed.

Milk: Often, but not invariably, clotted. Acid is formed. Clot, when formed, is not digested.

Indole not formed.

Nitrites not produced from nitrates.

Acid and gas from glucose, fructuso and galactose. Maltose, lactose, sucrose, raffinose, xylose, inulin, dextrin, atarch, cellulose, amygdalin, salicin, mannital and glycerol not fermented.

Coagulated albumin liquefied.

Blood scrum slowly softened and partially liquefied Not blackened. Mildly proteolytic.

Brain medium is blackened; slightly saftened, but not conspicuously liquefied.

Pathogenicity · Gumea pig may show slight subcutaneous edema; usually an effect. Non-pathogenic for rabbit.

Grows at 37°C.

Anaerobic.

Source Human feces, gaseous gargrege and septicemia.

Habitat: Not determined, other than these sources.

34. Clostridium parablfermentans comb. nov. (Bacillus parabifermentans Commt sand Sec. 'ireck.

fermentum, a ferment.

Rods: 0 5 to 0.7 by 4.0 to 50 microns, occurring singly, in pairs and in chains of 3 to 5 cells. Motile. Spores oval, terminal, swelling rods Gram-positive.

Glucose gelatin. Rapid growth with liquefaction.

Deep glucose agar colonies : Lenticular, regular, opaque, whitish. Agar disrupted by considerable gas of putrefactive adar.

Glucose broth: Abundant growth with uniform turbidity and with viscous sediment.

Milk: Acidified but not coagulated. Casein slowly precipitated with slow, but complete, digestion.

Indole formed in trace.

Glucose, lactose and sucrose fermented tn acids. (Gas not recorded.) Starch is not fermented.

Congulated albumin actively liquefied. Non-pathogenic for mouse.

Grows between 22°C and 37°C. Anaembie.

Source: From putrefying game (pheasant and guinea-fow!).

Habitat: Undetermined, other than this source.

35. Clostridium ovalare Bergey et al. (Bacillus putrificus orglaris Debono, Cent. f. Bakt., I Abt., Orig., 62, 1912, 231: Bergey et al., Manual, 1st ed., 1923, 336: Plectridium orglares Prévot, Ann. Inst. Past., 61, 1938, 58.) From Latin, nvai.

Rnds: 0 3 to 0.4 by 6.0 to 8 0 microns, straight or curving, ends rounded, occurring singly, in pairs and in short chains. Motile. Spores oval, terminal, swelling reds. Gram-positive.

Gelatin: Rapidly liquefied.

Deep glucose agar col lies: Small, globular, entire, becoming brownish Scant was is formed. Broth: Turbid.

Litmus milk: Aeid, peptonized without coagulation.

Indole not formed.

Acid and scant gas from glucose and lactose. Acid only from sucrose. Dulcitol not fermented.

Congulated albumin rendered transparent, then slowly peptonized, with a putrefactive odor.

Grows at 22°C and at 37°C.

Anserobic.

bea,

Source: Originally from putrid meat, later from feces.

Habitat: Not determined, other than these sources.

36. Clostridium zoogleicum Bergey et al. (Bacillus sporogenes zoogleicus Distaso, Cent. I. Bakt., I Abt., Orig., 59, 1911, 99, Bergey et al., Manual, 1st ed., 1923, 335 ) From Greek, zoogleal

Rods: Pairly long, occurring singly, in pairs and in short chains Motile. Spores large, oval, terminal, swelling rods Gran-positive

Gelatin Growth and liquefaction not recorded.

Deep agar colonies Small, gray, slightly opaque, becoming heart-shaped Gas is not formed

Broth: Turbid, then clearing with zoogleal sediment.

Litmus milk. Slowly coagulated, then digested. Litmus reduced.

Indole is formed in trace.

Acid but no gas from glucose Lactose

and sucrose not fermented
Congulated albumin liquefied, leaving a
clear fluid and zoogleal sedument

Grows at 37°C. Anaerobic.

Source: From buman feces.

Habitat: Undetermined, other than this source.

37. Clostidium thermosaccharolyticum McClung. (Jour. Bact., 29, 1935, 200; Terminosporus thermosaccharolyticus Prévot, Ann. Inst. Past, 61, 1933, 86) From Greek, heat, and sugar-digesting. Pade 0.4 to 0.7 by 3.5 to 7.5 mercons.

Rods 0.4 to 0.7 by 3.5 to 7.5 microns, slender, granulated, occurring singly and in pairs, not in chains. Motile with peritrichous flagella. Spores spherical, terminal, swelling rods. Gram-negative.

Gelatin Not liquefied.
Pea-infusion agar surface colonics

(anaerobic): Granular, grayish-white, raised center, with feathery edges

Deep glucose-tryptone agar colonies Small, lenticular, smooth Liver-infusion broth over liver meat

Turbidity and gas.
Litmus milk: Litmus reduced. Acid

and slow but firm coagulation; coagulum split with gas. Clot not digested

Indole not formed.

Nitrites not produced from nitrates. Gellulose not fermented.

Acid and gas from arabinose, fructose, galactose, glucose, mannose, ylose, cello-bose, lactose, maltose, sucrose, trehalose, devirm, givecgen, corn-starch, amygdalın, esculin, a-methyl glucoside and salıcın. Rafilnose weakly fermented. Rhammose, inuin, pectin, erythrioti, mositol, mannitol, glycerol, quereitol and Ca-batatie not fermented.

Coagulated albumin not liquefied,

Blood serum not liquefied

Brain medium not blackened or digested

Meat-medium not blackened or disected.

Non-pathogenic on feeding to white

rat, or by Injection into rabbit
Optimum temperature 55°G to 62°C.
Thermophilic.

Anaerobic.

Source: From hard-swell of canned goods, and from soil

Habitat Not determined, other than these sources

38 Clostridium caloritolerans Meyer and Lang. (Jour Inf Dis, 39, 1926, 321; Pleatridium caloritolerans Prévot, Ann. Inst Past., 61, 1938, 87.) From Latin, heat-enduring.

Rods-05 to 0.8 by 8 0 to 10 0 microns, noth rounded ends, occurring singly, in purs, in chains and in curved filaments. Mottle with peritrichous fingells Spores spherical or pear-shaped, terminal, swelling rods Gram-positive.

Gelatin: Not liquefied.

Glucose blood agar surface colonies (anaerobie): Small, flat, grayish, rhizoidal. Non-hemolytic

Deep liver agar colonies: Small, flat, transparent disks with large polar tufts. Some colonies become fluffy

Broth; Slight turbidity.

Glurose broth: Abundant turbidity,

with clearing by sedimentation. Gas is formed.

Brom cresol purple milk: No change. Indole not formed.

Acid and gas from glucose, galactose and maltose. Fruetose feebly fermented. Lactose, sucrose, raffinose, inulin, salicin, mannitol, inositol and glyc-

erol not fermented.
Coagulated albumin not liquefied.

Blood serum not liquefied.

Brain medium not blackened or digested.

Beef-heart mash medium: Reddened;

Non-pathogenic for mouse, guinea pig and rabbit.

Optimum temperature not determined. Grows at 37°C.

Anacrobic.
Source · From an old culture of Clostridium parabotulinum Type A

Habitat Not determined, other than this single isolation

30 Clostridium tetanotdes (Adamson) Hauduroy et al. (Unnamed anaerobe, Adamson and Cutler, Lancet, I, 1017, 688; Bacilius tetanoides (A) Adamson, Jour. Patli. and Bact. 22, 1018-10, 322; Hauduroy et al., Diet d Bact. Path, 1937, 140; Palmula macrospora Prévot, Ann. Inst Past., 61, 1038, 88, Acuforms macrosporus Prévot, Man. d. Class, etc., 1940, 166) From Latin, tetanus-like.

Rods 10 to 20 by 40 to 120 microns (averaging 10 to 15 by 60 to 70 microns), with rounded to slightly tapered ends, occurring singly, in pairs and in chains of 3 to 5 cells, but not in filaments. Motile only in young cultures Spores large, spherical, terminal, swelling rods. Gram-positive in young cultures, soon becoming Gram-negative.

Gelatin Not liquefied.

Glucose agar surface colonics (anaerobic): Circular, regular, opaque, bluishgray, moist, ehning, thick, raised. Surface flat, becoming conical in center with age On maist medium showing radiating, dendritic branching. Growth becomes tenacious mucoid

Plain agar surface colonies (anaerobic): Confluent, becoming an opaque film. Isolated colonies circular to slightly irregular. Dendritic branching and mucoid tendency less evident than on glucose agar.

Glucose agar stab: Thick growth along stab, starting 0.5 cm below surface. No gas or splitting of medium.

Neutral-red glucose agar: Reduced to orange by transmitted, and greenishfluorescent by reflected light.

Plain broth: Early slight turbidity, with clearing and mucoid sedimentation.

Glucose broth: Abundant turbidity and profuse mucoid sediment.

Milk: Slight and slowly increasing alkalinity, with slow separation of casein No further change.

Indole: Trace formed in broth.

Glucose and maltose fermented with acid but no gas. Lactose, sucrose, mannitol, starch and cellulose not fermented.

Coagulated albumin: Not digested or blackcaed. Meat medium: Not digested or black-

ened. Blood serum: Not digested or black-

ened.

Braia medium: Not digested or blackened.

Non-pathogenic for guinea pig and rabbit.

optimum temperature not recorded Grows well at 37°C.

Anaerobic.

Source: From war wounds, from postmortem blood culture, and from garden soil.

Habitat: Not determined, other than these sources.

40. Clostridium tetani (Fingge) Holland. (Tetanusbacillen and Tetanuser-

nicolaieri Trevisan, I generi e le specia delle Batteriacee, 1889, 23; Plectridium tetani Fischer, Jahrb. f. Wissensch. Botanik, 27, 1895, (147?); Holland, Jour. Bact., 6, 1920, 220; Nicollaierillus tetani Heller, Jour. Bact., 7, 1922, 7.) From tetanus, lockjaw.

Rods: 0 4 to 0 6 by 4 0 to 8 0 microns, rounded ends, occurring singly, in pairs, and often in long chains and filaments Mottle with peritrichous flagella. Spores spherical, terminal, swelling rods Gram-positive.

Gelatin, Slowly liquefied and blackened.

Serum agar surface colonies (anaerobic): Small, transparent, villous to fimbriate margin.

Blood agar is hemolyzed.

Deep agar colonies: Fluffy, cottony spheres, usually without visible central nucleus.

Broth: Slightly turbid. Gas 13 formed Some strains clear quickly by sedimentation

Litmus milk: Slow precipitation of easein, or soft clotting Clot slowly softened, but not definitely digested. Little gas is formed.

Indole is formed

Nitrites not produced from nitrates. Glucose not fermented

Carbohydrates not fermented.

Coagulated albumin slowly liquefied Blood serum slowly softened, with

feeble digestion.

Brain medium blackened and slowly

digested. Not actively proteolytic
Pathogenic and toxic. Forms a potent

evotovin for which an antitovin is prepared. Toxin intensely toxic on injection but not on feeding.

Optimum temperature 37°C.

Anaerobic.

Source: Originally isolated from animals inoculated with garden soil extract Frequently isolated from wounds in human tetanus.

Habitat: Common in soils, and in human and horse intestine and feces.

 Clostridium lentoputrescens Hartsell and Rettger. (Bacillus der Erweissfäulniss, Bienstock, Fortschr. d. Med . 1. 1883, 614 (Art IV, Bienstock, ibid , 612; Eiweissbacillus, Bienstock, Ztschr. f klin Med., 8, 1884, 38), Bacıllus albuminis Schroeter, in Cohn's Kryptogamen-Flora von Schlesien, S, 1, 1886, 162, Bacıllus putrificus coli Flügge, Die Mikroorg., 2 Aufl., 1886, 303; Pacinia putrifica Trevisan, I generi e le specie delle Batteriacee, 1889, 23; Bacillus putrificus Bienstock, Ann. Inst. Past. 13, 1899, 861; Bacillus butyricus putrefaciens Rodella, Ann Inst. Past., 19 1905, 804; Putribacillus vulgaris Orla-Jensen, Cent. f Bakt , II Abt., 22, 1909, 343: Clostridium putrificum Holland. Jour Bact., 5, 1920, 220; Putrificus bienstocki Heller, Jour Bact., 7, 1922, 8, Bacillus putrificus (coli) Lehmann and Neumann, Bakt Ding , 7 Aufl , 2, 1927, 661; Hartsell and Rettger, Jour Bact, 27, 1934, 39 and 497; Plectridium putrificum and Plectridium putrificum var. lentoputrescens Prévot. Ann Inst Past . 61, 1938, 88 ) From Latin, slowly made putrid.

Probable synonyms Bacillus radiatus Luderitz, Ztschr f. Hyg, 5, 1889, 149 (Corniba radiata Trevisan, loc. cit , 22; Recillus radiatus anaerobius Hopfic. Ztschr f Infkrnkh u. Hyg Haust 14, 1913, 392); Barıllus cadateris sporogenes (angerobicus) Klein, Cent f. Bakt, I Abt , 25, 1899, 279 (Bacillus cadateris Klein, idem; not Bacillus cadaveris Sternberg, Researches relating to the etiology and prevention of yellow fever, Washington, 1891, 212; not Bacillus cadaveris Migula, Syst d Bakt , 2, 1900, 646: Bacillus cadareris sporogenes Klein, loc. cit., 281; Plectridium cadaceris Prévot. Ann. Inst Past , 61, 1938, 88); Art XIV, von Hibler, Untersuch. u. d Path Anser, 1903, 3 and 413; Bacillus tetanoides (B) Adamson, Jour. Bact. and Path . 22, 1918-19, 388

Hartsell and Rettger, loc cit., conclude that their organism differs very materially either from Clostridium cochlearium or from Bacillus putrificus, as described by Cunningham, Jour. Bact., 24, 1822, 61, and, as it cannot be definitely related to any other anaerobic species (including the Elweisshacillus, Bienstock, loc. cit., Bacillus putrificus Coli Flugge, loc. cit., Bacillus putrificus Bienstock, loc. cit., etc.), they propose the name of Clostridium lentoputrescens for this species.

Rods: 0.4 to 0.6 by 7.0 to 9.0 microns, with rounded ends, occurring singly, in pairs and in chains. Motile with peritrichous flagella. Spores spherical, terminal, swelling rods. Weakly Grampositive, becoming Gram-negative.

Gelatin: Liquefied.

Agar surface colonies (anaerobic): Small, circular, flat, edge creaated to filamentous spreading. Develop a

ground-glass appearance.

Deep agar colonies: Fluffy spheres with fibrils radiating from a central nucleus.

Blood agar is hemolyzed

Litrus milk: Slow, soft coagulation or flocculent precipitation. Cascin is

slowly digested.
Indole is formed (Hall, Jour. Inf. Dis., 50, 1922, 141). Not formed (Hartsell and

Rettger, loc. cit., 509).

Nitrites not produced from nitrates.

Hydrogen sulfide formed in egg-meat medium.

Carbohydrates not fermented. Glucose slightly attacked without distinct acid (Hartsell and Rettger, loc. cit., 508).

acid (Hartsell and Rettger, loc. cit., 508).
Coagulated albumin slowly liquofied and blackened.

Blood scrum is liquefied. Gas is formed.

Brain medium slowly blackened and digested.

Egg-meat medium: Slightly turbid liquid. Meat reddened in 7 to 10 days, then digested with a foul odor.

Non-pathogenic for white mouse, guinea pig and rabbit Filtrate non-toxic on injection or feeding

Grows well at 37°C.

Anacrobie.

Source: From putrefying mest.

Habitat: Intestinal canal of human. Widely dispersed in soil. 42. Clestridium filamentosum Bergey et al. (Bacillus putrificus filamentosus Distaso, Cent. f. Bakt., I Abt., Orig., 59, 1911, 98; Bergey et al., Manual, 1st ed., 1923, 33; Padmula filamentosa Prévot, Ann. Inst. Past., 61, 1938, 88; Acuformis filamentosus Prévot, Man. d. Class., etc., 1949, 165.) From Latin, filamentosus 1949, 165.)

Rods: Slender, occurring singly, in pairs and in chains. Motile. Spores spherical, or nearly so, terminal, swelling rods. Gram-positive.

Gelatin: Liquefied.

Deep glucose agar colonies; Delicate, cottony flocculi. Only a trace of gas formed.

Broth: Turbid.

Litmus milk: May or may not coagulate and digest slowly (variable).

Indole formed in scarcely detectable trace. Odor of scatol.

Glucose is feebly fermented, with little gas Lactose and sucrose not fermented. Coggulated albumin: Rendered trans-

parent, then slowly inquefied. Grows well at 37°C.

Annerobic.

Source: From human feces.

Habitat: Not determined, other than this source.

43. Clostridium tetanomorphum (Bulloch et al.) Bergey et al. (Bacillus pseudo-4elanus, Type No. IX,—Tetanuslike Bacillus (Pseudotetanus Bacillus), McIntosh and Fildes, Med Res. Conne., Spec. Rept. Ser. No. 12, 1917, 11 and 32; Bacillus (clanomorphus Balloch et al., Med. Res. Counc., Spec. Rept. Ser. No. 39, 1919, 41; Macintoshilus ietanomorphus Heller, Jour. Bact., 7, 1922, 5; Bergey et al., Manual, 1st ed., 1923, 330, Plectridium tetanomorphum Prévot, Ann. Inst. Past., 61, 1938, 87.) From Greek, shaped lite the tetanus organism.

Synonyms or possibly related species:
Bactilus pseudotelani Migula, Syst. d.
Bakt., 2, 1900, 598 (Tetanusähnlicher Ba-

Schweiz, 1, 2000, ::, (eli

Chester, Man, Determ. Bact., 1901, 304; Pletiridium pseudolelanicum Prévot, Ann. Inst. Past , 61, 1933, 87; Pletridium pseudolelanicum Prévot, Man. d. Class., etc., 1910, 153); possibly identical with Bacillus fragilis Veillon and Zuber, Arch. d. Méd. Expt. et d'Anat. Path., 10, 1898, 536 and Bacillus ramosus Veillon and Zuber, bit., 1898, 636 and 18

Rods: Slender, with rounded ends, occurring singly and in pairs, not in chains. Motile with peritrichous flagella. Spores spherical, or nearly so, terminal, swelling

rods. Gram-positive.

Gelatin: Not liquefied. Gelatin is liquefied (Hall, Jour. Inf. Dis., 30, 1922, 501).

Agar surface colonies (anacrobic) Small, flat, irregularly circular, translucent, crenated.

Deep agar colonies: Small, opaque, irregular: not woolly or branched

Agar slant (anaerobic): Grayish, trans-

lucent growth. Broth: Turbid.

Litmus milk: Unchanged; or occasional slight reduction of litmus.

Acid and gas from glucose and maltose Fructose, galactose, lactose, sucrose, saircin, inulia, mannitol and glycerol not fermented.

Coagulated albumin not liquefied.

Blood scrum not liquefied.

Brain medium not blackened or digested.

Egg-meat medium: Slight gas formation in 48 hours. White crystals are deposited.

Non-pathogenic for guinea pig and tablit.

Grows at 30°C and 37°C.

Angerobic

Source: From war wounds and from soil.

Habitat: Not determined other than these sources Probably rather common in soil.

44. Clostridium alcaligenes Bergey et al. (Bacillus anaērobicus alcaligenes Debono, Cent. f. Bakt., I Abt., Orig , 62, 1912, 232; Bergey et al., Manual, 1st ed., 1923, 331; Palmula alcaligenes Prévot, Ann. Inst. Past., 61, 1938, 89; Acuformis elealigenes Prévot, Man. d. Class., etc., 1940, 165.) From French alcali, alkali and Latin suffix, producing.

Rods. Long, slender, occurring singly, in pairs and in short chains. Non mottle Spores spherical, terminal, swelling rods. Gram-nesitive

Gelatin . Not liquefied.

Deep glucose agar colonies: Lenticular

to arregular, or spherical, white, granular, entire Broth Uniform turbidity. Fecal odor.

Broth Uniterm turnicity. Fecal dec.
Milk Alkaline; casein slowly precipitated, with yellowish supernatant fluid
Indole is formed in abundance.

Acid and gas from glucose and lactose. Sucrose and dulcitol not fermented. Cultures have odor of valerianic acid.

Grows at 22°C and at 37°C

Anaerobic.

Source: From human feces.

Habitat: Not determined, other than this source.

45 Clostridium angulosum (Distaso) Hauduroy et al (Bactilus angulosus Distaso, Cent f Bakt, I Abt, Orig., 62,

sus Bergey et al , Manual, Ist ed., 1923, 260; Hauduroy et al., Diet. des Bact. Path , 1937, 91) From Latin angulosus, having angles, hooked.

Rods: Short, thick, with rounded ends, occurring singly and in pairs Long rods sometimes bent to form an obtuse angle. Encapsulated. Non-motile. Spores very small, sphenical, terminal, slightly

swelling rods Cram stain not recorded.

Plain gelatin: No growth at 20°C or at

37°C Glucose gelatin: Grows well at 37°C. Growth eloudy at first, then clears and liquefics, with whitish, powdery precipitate

Glucose agar deep colonies: Large,

angular, opaque, yellowish. Gas bubbles are formed.

Broth: Turbid.

Litmus milk: Acid and congulated in 14 days.

Indole is formed.

Acid and gas from glucose, lactose and sucrose. Butyric acid is formed.

Coagulated albumin not liquefied. Odor of skatol.

Optimum temperature 37°C

Anaerobic.

Distinctive character: Resembles the Bacille neigeux, Jungano, Compt. rend. See. Biol , Paris, 62, 1907, 677, in form, but not in other respects.

Source: From human feces.

Habitat: Not determined, other than this source

46. Clostridium putrefaciens Bryde) Sturges and Drake (Bacillus putrefaciens MeBryde, U S D A . Bur. An Ind , Bull 132, 1911, 6; Sturges and Drake, Jour. Bact , 14, 1927, 175, Palmula putrefaciens Prévot, Ann. Inst. Past , 61, 1938, 89; Acuformis putrefactens Prévot. Man d Class , etc , 1940, 165 ) From Latin, putrefying.

Description from McBryde (loc. cst.) and amplified from Sturges and Drake

(loc. c11.).

Rods 05 to 07 by 30 to 150 microns. rounded ends, occurring singly, in pairs, and in chains and filaments. Non-motile Spores spherical, terminal, swelling rods Gram-positive

Gelatin: Liquefied

Agar surface colonies (anaerobic) Small, filamentous.

Agar slant (anaerobic) Scanty, white, beaded, glistening growth

Broth Moderate turbidity flocculent sediment.

Litmus milk: Rennet coagulation, peptonized Litmus reduced

Indole not formed.

Nitrites not produced from nitrates Slight production of hydrogen sulfide. Acid and gas from glucose Lactose, sucrose, maltose and starch not fermented.

Congulated albumin liquefied.

Blood serum liquefied.

Brain medium blackened and slowly digested.

Minced pork medium · Slight disinte-

gration; sour, putrefactive odor. Non-pathogenic.

Optimum temperature 20°C to 25°C. Slow growth at O°C and no visible growth at 37°C.

Annemhic.

Source: From muscle tissue of hogs at alaughter.

Habitat: Not determined, other than this source.

47. Clostridium nigrificans Werkman and Weaver. (Iowa State Coll. Jour. Sci., 2, 1927-28, 63; Werkman, Iowa State Coll. Research Bull. 117, 1029, 165.) From Latin niger, black and faciens. making,

Reds: 03 to 0.5 by 3.0 to 6.0 microns, with rounded ends Motile. Spores oval, subterminal, slightly swelling rods. Gram-positive.

Gelatin: Not liquefied.

Deep agar colonies: Show blackening of medium around colonies. Black inereased by adding 01 per cent ferric chloride to medium.

Milk: Not recorded

Indole not formed.

Nitrites not produced from nitrates. Glucose not fermented

Carbohydrates not fermented.

Coagulated albumin not liquefied.

Blood serum not liquefied.

Brain medium blackened but not digested.

Hydrogen sulfide produced cystine.

Non-pathogenic to man, guinea pig, mouse, rat and rabbit.

Optimum temperature 55°C. Thermonhile, growing at 65°C to 70°C.

Anaerobic. Distinctive character: Black colonies

ın agar media.

Source: From canned corn showing sulfur stinker spoilage, also occasionally from soil and manure.

Habitat · Presumably soil, although de tected with great difficulty.

48. Clostridium belfantil (Carbone and Venturelli) Spray. (Bacillus belfanti: Carbone and Venturelli, Boll 1st Secoter, Milan, 4, 1925, 59; not Bacillus belfanti: Migula, Syst. d. Bakt. 2, 1900, 767; Spray, m Manual, 55th. ed., 1939, 759, Endosporus belfanti: Prévot, Ann. Inst Past., 61, 1938, 75). Named for Belfanti. an Italian bacteriologist.

Rods. 04 to 06 by 1.5 to 70 microns, thick and straight, occurring singly, in pairs and in short claims Motile Spores large, oval, central to subterminal, and limp rods Usually Gram-negative, occasional cells Gram-positive

Granulose reaction negative

Gelatin . Not liquefied.

Plain agar surface colonies (anaerobie) Large, round, opaque, with filamentous edge

Deep agar colonies. Arborescent along the stab. Gas is formed.

Plain broth Diffuse turbidity, clearing by precipitation No pigmentation Gas is formed.

Potato mash Forms a foam becoming violet in 24 to 48 hours, persisting 3 to 6 days, but disappearing on exposure to air.

Potato slant: Grayish pellicle, becoming violet in 24 to 48 hours. Gas of alcobolic odor is produced. No acetone

Glycerinated potato. Thin, graysh pellicle, not becoming violet.

Milk Coagulated in 24 to 48 hours. Clot broken by gas.

Milk agar: Abundant growth Gas of butyric odor is liberated.

· Indole is formed

Hydrogen sulfide not formed. Acid and gas from glucose, fructose, maltose, sucrose, lactose and roannitol Starch and inulin weakly fermented.

Coagulated albumin not liquefied Blood serum not liquefied Grows well at 37°C. Annerobic.

Specifically agglutinated only by homologous antiserum

Source From retting beds and from air Habitat Not determined, other than these sources.

Norse Six other strains of similar piginenting, sporulating anaerobes are described by the authors. These have the general characters of Clostridium belfantii, but differ in certain particulars, such as color of pigment, fermentation and specific agglutination. Present information does not permit accurate systematic differentiation.

48a Clostrudium inaggiorai (Cartoine and Venturelli) Spriny (Bacillus maggiorai Carbone and Venturelli, loc ett. 59, Spray, in Manual, 5th ed., 1939, 759, Endosporus maggiorai Prévot, loc ett., 76) Named for Maggiora, an Italian bacteroogst

Characters in general those of the group, but does not produce indole Violet pigmentation persisting only 24

hours

No alcoholic odor from cultures Specifically agglutinated only by homologous antiserum

From mud from bed of stream in Italy

48b Clostridium derossii (Carbone and Venturellii Spray (Bacillus de rossii Carbone and Venturelli, loc ett. 53; Spray, in Manual, 5th ed., 1939, 750, Endosporus rossii Prévot, loc ett., 75) Named for G de Rossi, an Italian bacteriologist

Characters in general those of the group Greenish pigmentation on potato shart, changing to violet or orange

Indole is formed Spedifically agglutinated only by homolarous antiserum

From soil in Italy.

48c Clostridium ottolenghii (Carbone and Venturelli) Spray. (Bacillus ottolenghii Carbone and Venturelli, loc cit., 59, Spray, in Manual, 5th ed., 1939, 760, Endosporus ottolenghii Prévot, loc. cit., 76.) Named for Ottolenghi, an Italian bacteriologist.

Characters in general those of the group. Potato slant digested to a grayishbrown mash. Greenish pigment changing to reddish. Gas of disagreeable odor is formed.

Indole is formed.

Specifically agglutinated only by homoiogous antiserum.

From mud from bed of a stream in Italy.

48d. Clostridium paglianti (Carbone and Venturelli) Spray. (Bacillus paglianti Carbone and Venturelli, loc. cit., 60; not Bacillus paglianti Trevisan, I generi e le specio dello Batteriace, 1889, 19; Spray, in Manual, 5th ed., 1939, 760; Endosporus paglianti Prévot, loc. cit., 76.) Named for Pagliani, an Italian hacteriologist.

Characters in general those of the group. One or two subterminal spores

are said to be formed.

Greenish pigmantatioe on potato, browning with ago.

Indolo is formed.

Specifically agglutinated only by homologous antiscrum.

From soil in Italy.

48c. Clostridium lustígii (Carbone and Venturelli) Spray. (Bacillus lustígii Carbone and Venturelli, loc. cit., 59; not Bacillus lustígii Trevisan, in lili 'quoted from DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 938, not Bacillus lustigi Chester, Man. Determ. Bact., 1901, 394; Spray, in Manual, 516 ed., 1939, 760; Endosporus lustígii Prévot, loc. cit., 76) Named for Lustig, ao Italian bacteriologist.

Characters in general those of the group. Green pigmentation on potato slant.

Indole is not formed.

Specifically agglutinated only by homologous antiserum.

From mud and soil in Italy.

48f. Clostridium sclavoi (Carbone and Venturelli) comb. nov. (Bacillus sclavoi Corbone and Venturelli, loc. cit., 60; Endosporus sclavoci Prévot, loc. cit., 76.) Named for Sclavo, an Italian bacteriologist.

Characters in general those of the group. Greenish to brown pigmentation on points short.

Indole is not formed.

Specifically agglutinated only by homologous antiserum.

From retting flax in Italy.

49. Clostridium veoturelli (de Tomasi) Spray. (Bacillus venturelli de Tomasi, Boll. Ist. Sieroter. Milanese, 4, 1925, 203; Endosporus venturelli Prévot, Ann. Inst. Past., 61, 1933, 76; Spray, in Manual, 5th ed., 1930, 760.) Named for Venturelli, an Italian bacteriologist.

Rods: Pleomorphic, fusiform to straight or slightly curved, with medium, of onds. Size variable with medium, of to 0 8 by 2.5 to 8.0, and up to 20 Omicroas. Occurring singly, in pairs, in chains, or frequently in parallel groupings. Motile Capsulated. Spores oval, central to excentric, swelling rods. Gram-negative.

Granulose reaction positive; showing

violet granules with todine.
Gelatin: No growth; no liquelaction.

Glucose agar surface colonies (anacrobic): Round, becoming rose-colored. Plain agar slant (anaerobic): No

growth.

Maltose agar stab: Colonies lenticular, yellowish, turning to rose. Oder of acctance.

Ploin broth: No growth.

Potato slant (anaerobic): Becomes mucilaginous. Bubbles of gas of amylic odor.

Potato mash: Very abundant growth;

Milk with CaCO: Congulated; becoming yellow, then pale rose. Amylic odor.

Acid and gas from glucose, maltose, sucrose, fructose, lactose, inositol, detrin ond starch. Arabinese, glycerol, magnitol and inulin not fermented (cited from Weinberg et al., Les Mic. Anaer., 1937, 899).

Fermentation products include especially acetone and amyl alcohol, and amaller amounts of propyl, butyl and isolutyl alcohols, and acetic acid.

Congulated albumin not digested.

Blood serum not liquefied, forms a

small amount of yellowish liquid.

Optimum temperature 18°C to 20°C
Inhibition of growth and pigmentation

above 25°C

Distinctive character. Forms a rosecolored pigment which is soluble in alcohol, but not in water, etheror chloroform. Source · From potato

Habitat. Not determined, other than this source.

50 Clostridium roseum McCoy and McClung. (Arch f. Mikrobiol, 6, 1935, 237) From Latin roseum, pink.

Rods: 0.7 to 0.9 by 3.2 to 4.3 microns, occurring singly, in pairs and in short chains Motile with perticious flagella Spores oval, subterminal, swelling rods to clostridia Gram-positive, becoming Gram-negative

Granulose reaction positive in clostri-

Glucose gelatin · Liquefied.

Plain agar slant (anaerobic). Surface growth scant, scarcely perceptible

Glucose agar surface colonies (anaerobie) Raised, smooth, edges slightly irregular Pink to orange pigment Deen glucose agar colonies. Compact,

lenticular, pink to red-orange.

Blood agar not hemolyzed Piguentation (anacrobic) Colonies red-orange, becoming purplish-black on acration

Plain broth . No growth.

Glucose broth: Abundant, uniform turbidity, with much gas

Litmus milk. Stormy coagulation. Litmus reduced, but obscured by pink pigment Clot slowly softened Proteolysis demonstrable on milk agar.

Potato Rapid digestion to a clear yellow fluid and bluish sediment. Much gas with butylic odor. Corn mash: Resembling reaction of Clostridium acetobutylicum, but with flesh-orange pigment, becoming slowly purple at surface on ageing.

Hydrogen sulfide formed from thiosul-

Nitrates reduced to ammonia.

Nitrites reduced to ammonia.

Indele not formed.

Acid and gas from xylose, arabinose, glucose, mannose, fructose, galactose, lactose, mallose, sucrose, raffinose, starch, dettrin, glycogen, inulin, pectin and salicin Esculia and amygdaln weakly fermented Mannitol, erythritol, glycerol, a-methyl glucoside, Ca-lactate and cellulose not fermented.

Congulated albumin cubes · Softened and vellowed by slow digestion

Blood serum not liquefied.

Brain medium not blackened or digested Non-pathogenic for guinea pig and

rabbit
Ontimum temperature about 37°C

Optimum temperature about 37°C. Growth occurs from 8°C to 62°C. Anaembic.

Source. From German maize Habitat. Probably occurs in soil.

51. Clostridium cbromogenes Prévot. (Chromogenie anaerobe, Ghon and Mucha, Gent f Bakt, I Abt, Orig., 42, 1906, 405; Bacillus anaerobius chromogenes LeBlaye and Guggenheim, Man. Prat. d Diag Bact, 1914, 321; Prévot, Ann Inst. Prat., 51, 1933, 85) From Latin, color-producing.

Rode Moderate size, cocoid to elongate, ends rounded to slightly pomted; straight to slightly eurved Occurring singly, parred, in short chains and in long, curved to coiled filaments Caspulate, especially in serum media. Motile, with many peritrichous flagells Spores abundant, oval, central, subterminal, to apparently terminal at mutaration, swelling rods to elubs and clostridia Grampositive

Granulose negative with iodine solution.

Gelatin: Liquefied ia 48 hours. Diffuse turbidity, clearing with abundant, whitish-gray sediment, which later becomes red to violet-red. Upper (1 cm) layer sbows diffuse, red pigment.

Deep plain agar (without peptone): Growth sparse. Pigment not formed in absence of peptone.

Blood agar surface colonies (anaerobic): Grayish, moist, shining, flat; edges lobate

with finely dendritic-tufted edges. Blood agar is hemolyzed.

Glucose agar surface colonics (anaerobic): As on blood agar. Growth

slightly less profuse.

Glucose agar deep coloates: Grayishwhite, multi-lobate, with dense center and dendritic, tutted edges. Growth begins about 1 cm below surface. Gas abundantly formed. Diffuse, red pigment appears in superficial layers after 4 to 5 days.

Glucosa meat-infusion broth: Abundant, diffuse turbidity with much gas.

times fails At best, moderate turbidity and sediment. No gas.

Synthetic fluid media (Uschinsky, etc): No growth (unless peptone is added). Growth is proportionate to added peptone

Potato slant (anaerobic): Growth delicate, shining, grayish-yellow Fecal ador-

Milk: Spongy coagulation after 3 to 4 days. Abundant gas. Turbid, yellowish whey is expressed. Casein clot gradually digested in 4 to 5 weeks Fecal odor.

Indole is not formed.

Hydrogen sulfide is abundantly formed Caugulated albumin (hydrocoel and ascitic-fluid): Digested and blackened, with moderate gas of fecal odor. When covered with agar, the agar plug shows diffuse, red pigmentation

Pathogenicity: Weakly pathogenic for white mice and guinea pigs. Produces hemorrhagic, scrous peritonitis after intraperitoneal inoculation. Death due apparently to a weak toxin. Virulence increased by animal passage.

Grows well at 21°C and at 37°C.

Anaerobic.

Distinctive character: Red pigmentation which is increased on addition of chlorine, or of bromine-water. Although produced by an anaerobe, pigment appears only in serated zone and depends on peptone content of medium.

Source: From pus of a human peri-

nephritic abscess.

Habitat: Not determined, other than this single source.

52. Clostridium felsineum (Carbone and Tombolato) Bergey et al. (Bacillus felsineus Carbone and Tombolato, Le Staz. Sper. Agrar., Ital., 50, 1917, 553. Ruschmann and Bavendamm, Cent. Bakt., HAbt., 64, 1925, 349; Van der Lek, Thesis, Dellit, 1930, (1437); Clostridium felsinus Bergey et al., Manual, 3rd ed., 1930, 453.) Named for Felsinea, the ancient name of Bolozan, Italy.

Described from Ruschmann and Bavendamm (loc cit.), from the Kluyver strain used by Van der Lek (loc. cit.), and from McCoy and McClung, Arch. f. Mikro-

biol., 6, 1935, 230.

Rods. 03 to 0.4 by 3.0 to 50 merons, occurring singly, in pairs and in short chains. Motile with peritrichous flagella. Spores oval, subterminal, swelling rolls to clostidia. Gram-positive, becoming Gram-negative.

Granulose positive in the clostridial stage.

Glucose gelatin : Liquefied.

Plain agar slant (annerobic): Surface growth scant, scarcely perceptible. Glucose agar surface colonies (anner-

obic): Raised, smooth, slightly irregular, yellow-orange.

Deep glucose agar colonies: Compact, lenticular, opaque, yellow. Blood agar not hemolyzed.

Pigmentation (anaerobic): Yelloworange, ageing to brownish. Not changing on aeration Plaio broth: No growth.

Glucose broth: Abundant, umform turbidity, with much gas. Yellow slimy sediment.

Litmus milk: Acid and coagulation. Litmus reduced. Clot torn and yellowed

No visible digestion.

Potato · Digested to a yellow slime

Much gas with butylic odor.

Corn mash: Resembling reaction of Clostridium acetobutylicum, but with flesh to orange pigmeet.

Indole not formed

Nitrates reduced to ammonia

Nitrites reduced to ammonia

Acid and gas from arabinose, vylose, glucose, mannose, fructose, galactose, catocke, actiones, estrose, raffinose, starch, devtrin, inulin, glycogen, pectin and salicin. Mannitol, erytlintol, glycerol, Ca-lactate and cellulose not fermented

Fermentation products acclude butyl and ethyl alcohol, acctone, organic acids (probably butyric and acctic), H<sub>2</sub> and CO<sub>2</sub>

Coagulated albumin cubes Softened and vellowed by slow digestion

Blood scrum not liquefied

Brain medium not blackened or digested

Non-pathogenic for guinea pig and rabbit

Grows at 37°C.

Anserobic.

Source From retting flax

Habitat Not determined Found io soil in Italy, Argentina and in the United States.

53 Clostridium carbonel Amaudi (Soc Intern Microbiol, Boll Sez Ital, 8, 1936, 251, and Boll lat Sieroter, Milano, 16, 1937, 659, Inflabilis carbones Prévot, Man. d Class, etc., 1940, 96) Named for Carbone, an Italiao bacteriologist

Rods: 08 to 10 by 3.5 to 45 microns, with ends slightly tapered Kon-motile Spores oval, terminal, 08 to 10 by 10 to 1.75 microns, swelling rods. Grain-positive.

Graoulose reaction strongly positive with poduce solution

Gelatin : No growth

Glucose and lactose gelatin No growth.

Plain agar surface colonics (anaerobic).

Flat, shining, colorless, with irregular

Malt agar surface colonics (anaerobic) -Creamy to slightly reddish colonies with arregular edges.

Roux-potato slant (anserobic) Punctiform, raised, opaque, deep red colonies, becoming almost violet

becoming almost violet

Plain agar stab Only traces of growth
along stab.

Glucose and maltose agar stab; No growth.

Plain broth Very slight, colorless, diffuse turbidity

Glucose broth Very slight turbidity.
Maltose broth Intense turbidity, with
profuse, reddish-yellow sediment

Tarozzi broth . Slight, diffuse turbidity.
Indole not formed

Hydrogen sulfide not formed.

Milk Soft coagulation, with slight, fine reddish flocculence Whey turbid and colorless Reaction acid Clot not digested

Digest-milk (optimum medium) Very abundant turbidity, with bright red floculent sediment, diffusing uniformly on shaking

Congulated egg-yolk broth Slight turbidity, no digestion

Coagulated egg-albumin broth Slight turbidity, no digestion

Coagulated scrum (Loeffler, anaerobic)
Poor growth, flat, red surface colonies
No direction

Brain medium Not recorded

Cellulose not attacked. Hemp is not retted

Ferments weakly Glucose, maltose, sucrose, galactose, fructose and rafilinose. Slow and partial fermentation of lactose (only in acidified medium). Starch alightly fermented. Fermentation products include II., CO., Cll., butyric acid and traces of ethyl alcohol Non-pathogenic for sheep, rabbit, guinea pig or white mouse.

Optimum reaction pH 7.0 to 7.2; minimum pH 6.0; maximum pH 80.

Optimum temperature 37°C. Grows slowly at 25°C to 30°C; growth ceases at 40°C.

Anacrobic.

Distinctive character: Production of a brilliant red pigment, soluble in amyl alcohol, petrol-ether, xylol and abiline oil. Partly soluble in other, chloroform and acctone. Pigment very stable in light.

Source: From macerated raw potato infusion.

Habitat: Not recorded, other than from this single source.

54. Clostridium spumarum (Prévot and Pochon) comb. nov. (Pleefridium spumarum Prévot and Pochon, Compt. rend Soc. Biol., Paris, 130, 1939, 966.) From Latin, foam or froth.

Rods: 0.5 by 40 microns, motile. Spores are eval and terminal, swelling rods. Gram-positive

Gelatin Liquefied in 15 days.

Deep agar. Forms small cottony

colonies and a few gas bubbles.

Peptone water. Turbidity and slight

sediment.

Milk. Congulated in 5 days, but clot is not digested.

Indole is produced.

Hydrogen sulfide is formed (medium not stated)

Sugars not attacked immediately after isolation.

After 1 month cultivation, ferments slowly glucose, fructose, galactose, maltose, arabinose, xylose, sucrose, manniol and starch. Inulin is not fermented.

Cellulose (in synthetic medium) is fermented chiefly to acetic and butyric acids, together with inflammable gas and traces of ethyl alcohol.

Coagulated albumin not attacked.

Brain medium not blackened.

Optimum temperature around 37°C. Not thermophilic. Anaerobic.

Distinctive characters: Does not produce pigment, and ferments a variety of earbohydrates.

Source: From the scum of sugar refining vats.

Habitat: Not determined, other than from this source.

55. Clostridium werneri Bergey et al. (Bacillus cellulosam fermentans Werner, Cent. f. Bakt., 17 Abt., 67, 1928, 237, Bergey et al., Manual, 3rd ed., 1939, 452; Bacterium cellulosam Jepson, Bull. Entomol. Res., 82, 1937, 163; Terminosporus cellulosam fermentans Prévot, Ann. Inst. Past., 61, 1938, 56; Terminosporus cellulosam fermentans Prévot, Man. d. Classeam-fermentans Prévot, Man. d. Classeam-fermentans Prévot, Man. d. Classeam, etc., 1940, 148.) Named for Erich Werner, the German bacteriologist who first isolated this borganism.

Related species: Probably closely related to Clostridium omelianshit.

Rods: 0.5 to 0.7 by 1.5 to 7.0 microns, occurring singly and in pairs, but not in chains. Motile with peritrichous flagella. Spores oval, terminal, swelling rods. Gram-negative.

Cellulose agar slant (snacrobic): Growth only in contact with cellulose. Growth grayish black; agar is darkened. Gas is formed.

Agar slant (anaerobic): No growth Broth: No growth.

Broth with filter paper: Poor growth; cellulose weakly attacked.

Omelianski solution with filter paper: Abundant growth; cellulose digested with formation of H<sub>2</sub> and CO<sub>2</sub>.

Hydrogen sulfide is formed in the Omelianski medium, presumably from the (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> and MgSO<sub>4</sub>.

Glucose not fermented.

Carbohydrates, other than cellulose, not fermented

Nou-pathogenic for mice.

Optimum temperature 33°C to 37°C.

Anaerobic.

Source · From larvae of rose loaf beetle (Potosia cuprea). Habitat: Occurs in soil and in feces of herbivorus animals.

56. Clostridium cellulosolvens Cowles and Rettger (Jour. Bact., 21, 1931, 167; Caduceus cellulosolvens Prévot, Ann Inst. Past , 61, 1938, 86.) From chemical

term, cellulose, and Latin, dissolving.
Rods. 0 5 by 2.0 to 6.0 migrons, commonly curving, occurring singly and in pairs, not in chains. Non-motile Spores spherical, terminal, swelling rods. Gramstain uncertaing usually Gram-necative.

Does not grow in routine media, except where cellulose or certain few carbohydrates are added.

Surface colonies on dextrin-cysteine meat infusion agar (anaerobic) Tuny, round, transparent dew-drops; finely granular, with smooth edge.

Acid and gas from cellulose, devtrin, arabinose, sylose and soluble starch. Glucose, fructose, mannose, lactose, maltose, sucrose, melectiose, rafilmose, multisalicin, amygdalin, adontol, duletol, erythritol, glycerol, inositol, mannitol, sorbitol and gum arabin on thermented

Cellulose decomposed to H<sub>2</sub>, CO<sub>2</sub> and organic seids.

Grows at 37°C.

Anacrobic.

Source · From horse feees.

Habitat. Not determined, other than this source. Probably widely dispersed in manured soil.

57. Clostridium dissolvens Bergey et al. (Bacilius cellulosa dissolrens Khouvine, Ann. Inst. Past., 57, 1923, 711, Bergey et al., Nanual, 2nd et , 1925, 344; Caduceus cellulosae dissolvens Prévot, Ann Inst. Past , 67, 1938, 85.) From Latin, dissolving.

Rods. Slender, ranging from 2.5 to 12 5 microns in length, occurring singly, occasionally in pairs, but not in chains. Non-motile Spores oval, terminal, andling rods Gram-negative.

Cellulose is digested by the formation of an endocellulase which acts only when the bacteria are attached to the cellulose. Saccharides are formed from cellulose, also CO<sub>2</sub>, H<sub>2</sub>, ethyi alcohol, acetic, lactic and butyric acids

A yellow pigment is formed in presence of cellulose.

Glucose not fermented.

Carbohydrates, other than cellulose, not fermented.

Non-pathogenic for guinea pig.

Optimum temperature Grows between 35°C and 51°C, without a definite optimum

Apperobic.

Distinctive character: Grows only in media containing cellulose, in the presence of which it produces a yellow pagment

Source From human feres. Habitat Intestinal canal of man

 Clostridium omelianskii (Henneberg emend. Clausen) comb, nov lulose fermenting microbe, Omelianski, Compt. rend. Acad Sci , Paris, 121, 1805. 653 (Bacillus fermentationis cellulosae Omelianski, Arch Sci Biol. (Russ.), 7, 1899, 419; Bacterium cellulosis Migula, Syst. d Bakt . 2, 1900, 513); Barille hydrogenique, Omelianski, Arcb. Sci. Biol. (Russ ), 9, 1902-03, 263 (Wasserstoffbacillus, Omclianski, Cent. f. Bakt., II Aht., 8, 1902, 262; Bacillus fossicularum Lehmann and Neumann, Bakt Diag, 4 Aufl , 2, 1907, 466, Bacellus hydrogenes Jungano and Distaso, Les Anaérobies, 1910, 147; Bacillus omelianskii Henneberg, Cent f Balt, H Abt, 55, 1922, 276, emend Clausen, Cent f Bakt II Abt . 84, 1931, 40 and 54, Omelianskillus hudrogenicus Heller, Jour. Bact . 7, 1922. 5. Caduceus cellulosae hydrogenicus Prévot. Ann. Inst Past , 61, 1938, 86); Bacille formenique, Omelianski, Arch. Sci Biol (Russ), 9, 1902-03, 263 Methanbacillus, Omelianski, Cent. f Bakt , H Abt , 11, 1903-01, 370, Bocillus methaniques Lehmann and Neumann. Bakt Ding , 4 Au0 , 2, 1907, 466, Cellobacillus methanigenes Orla-Jensen, Cent. f. Bakt , Il Abt., 22, 1909, 343; Bucellus methanta Jungano and Distaso, Lea

Anaérobies, 1910, 146; Caduceus cellulosae hydrogenicus var. cellulosae methanicus Prévot, Ann. Inst Past., 61, 1938, 86; Caduceus cellulosae methanicus Prévot. Man. d. Class., etc., 1940, 150).) Named for Omehanski, the Russian bacteriologist who first described this type.

This species was apparently first isolated and studied in pure culture by Clausen (loc. cit.). From his studies he concludes that Omelianski's Wasserstoffand Methanbacillus are but a single species, and that the gaseous fermentation products (Hz, CO, and CH,) were affected by the symbiotic forms always present in Omelianski's cultures.

His evidence is quite convincing, and the organism is presented here from his

description.

Rods: Length varying with the medium, 0 5 to 0 7 by 5.0 to 15.0 microns. straight to slightly curved. Occurring chiefly singly, occasionally in pairs, frequently parallel in groups, never in chains or filaments. Young cells motile, but motility disappearing with sporulation. Flagella not demonstrable. spherical, terminal, swelling Spores 10 to 15 microns in diameter, varying with medium. Gram-positive, becoming Gram-labile on sporulation

Young vegetative cells colored wine-red

with sodine solution.

Gelatin (plus asparagine): Liquefied in 6 to 10 days. Medium remains perfectly clear.

Asparagine agar deep colonies: Grayishwhite, delicate, cottony, with fine radial outgrowths

Asparagine agar surface colonies (anaerobic) - Poor growth, delicate, translucent, filmy, scarcely discernible.

Cellulose liver broth Solution remains visibly clear and does not darken with age. Occasional large gas bubbles arise.

Indole not formed.

Ammonia not formed

Nitrates not reduced to nitrites Traces of HaS produced in morganic solutions.

Milk: Soft coagulation in 24 hours.

Amorphous clot shrinks and settles, forming a yellowish-red to orange sediment, with turbid supernatant whey.

Brain medium : Not digested or blackened; no visible evidence of growth

None of the following carbohydrates attacked: Maltose, mannitol, lactose, glucose, sucrose, galactose, fructose, starch, salicin, glycerol and inulin.

Cellulose apparently the primary Csource, but is only weakly attacked by pure cultures.

Yellow pigment not recorded in presence of cellulose (see Clostridium dissolvens).

Non-pathogenic for mice; other animals not recorded.

Optimum reaction pH 7.0 to 7.4; grows between pH 6.0 and 8.4

Optimum temperature 37°C to 42°C. Anaerobic: Growing at 25 to 30 mm mercury pressure.

Distinctive characters: Ability to . . estante for on

without requiring presence of cellulose. Spores resist heating at 100°C for 90 minutes. Source: From human, cow and horse

exercta, from cow's stomach' rontents, from cheese and from soil.

Habitat: Intestinal canal of animals, and presumably thence widely disseminated in soil.

59 Clostridium carnis (Klein) Spray. (Art V. von Hibler, Cent f. Bakt., I Abt., 25, 1899, 515; Bacillus carnis Klein, Cent. f. Bakt , I Abt., Orig , 35, 1904, 459, also Trans. Path. Soc., London, 55, 1901, 74, Art. VI, von Hibler, Untersuch. u. d. Path. Anaer , 1908, 3 and 406; Hiblerillus sextus Heller, Jour Bact , 7, 1922, 6; Bacillus lactiparcus Lehmann and Süssmann, in Lehmann and Neumann, Bakt. Diag , 7 Aufl , 2, 1927, 647; Plectridium carnis Prévot, Ann. Inst. Past, 61, 1938, 87, Spray, in Bergey et al., Manual, 5th ed , 1939, 750, Clostridium

sextum Prévot, Man. d Class, etc., 1940. 136.) From Latin, of flesh.

Description from Hall and Duffett,

Jour. Bact , 29, 1935, 269.

Rods: 0 5 to 0.7 by 1 5 to 4 5 microns, occurring singly, in pairs, rarely in chains of 3 to 4 cells. Motile with peritrichous flagella. Spores oval to clongate, subterminal, slightly swelling rods Gram-positive.

Gelatin: Not liquefied or blackened Agar surface colonies (serobic) Minute, transparent dew-drops, becoming flat and lobate.

Blood agar surface colonies (aerobic) Similar to plain agar Slight hemolysis. Deep agar colonies : Lenticular, becom-

ing nodular to arborescent

Milk: Abundant gas, but no coagulation or other change.

Indole not formed.

Acid and gas from glucose, galactose, fructose, maltose, lactose, sucrose, amygdalın, salıcin and dextrin Trehalose, raffinose, vylose, arabinose, starch, inulin, mannitol, dulcitol, sorbitol, glycerol and mosital not fermented.

Coagulated albumin not liquefied

Blood serum not liquefied.

Brain medium not blackened or digested

Pathogenic for guinea pig, a bite rat and rabbit. Forms an exotoxin of moderate intensity, producing edema, necrosis and death on sufficient desage

Grows well at both 37°C and at room temperature

Angerobic and microgerophilie, growing delicately on aerobic agar slants.

Source: Originally isolated from a rabbit inoculated with garden soil (von Hibler); from contaminated beef infusion (Klein)

Habitat : Probably occurs in soil

60 Clostrldium histolyticum (Wemberg and Seguin) Bergey et al (Bacillus histolyticus Weinberg and Segum, Compt rend. Acad. Sci , Paris, 163, 1916, 419; Weinbergillus histolyticus Heller, Jour Bact., 7, 1922, 9; Bergey et al , Manual,

1st ed., 1923, 328 ) From Greek, tissuedissolving.

Rods. 0 5 to 0 7 by 3 0 to 5 0 microns. occurring singly and in pairs. Motile with peritrichous flagella. Spores oval, subterminal, swelling rods. positive

Gelatin Complete liquefaction in 24 hours Blood agar surface colonies (aerobic):

Minute, round dew-drops, Blood is hemolyzed. Deep agar colonies Variable; from len-

ticular, lobate, to fluffy, according to the agar concentration.

Agar slant (aerobic) Grows aerobically in barely perceptible film, or in tiny, emooth, discrete colonies

Broth Turbid, with slight precipitate. Indole not formed.

Nitrates not produced from nitrates Litmus milk. Softly coagulated, then slowly digested. Little gas is formed. Carbohydrates are not fermented.

Coagulated albumin slowly liquefied Blood serum slowly liquefied with darkened, putrid fluid

Brain medium blackened and directed with outrefactive odor.

Egg-meat medium. Little gas is formed. Meat first reddened, then darkened in 3 days Digestion apparent in about 24 hours Nauseous odor Tyrosin crystals are abundant after about a neek Pathorenie for small

laboratory animals Produces a cytolytic exotoxin which causes extensive local necrosis and sloughing on injection Not toxic on feeding Gross well at 37°C.

Anaerobie and microacrophilie. Grows feebly on aerobic agar slant.

Source. Originally isolated from war wounds, where it induces active necrosis of tissue

Habitat. Not determined, other than source stated Found occasionally in feces and soil. Apparently widely, but anarsely, dispersed in soil.

Bacillus dimorphobutyricus Lehmano (Dimorpher Butterand Neumann. säurebacillus, Grassberger and Schattenfroh, Arch. f. Hyg., 60, 1907, 59; Lehmann and Neumann, Bakt. Diag., 4 Aufl., 2, 1907, 441.) From milk.

elegans Romanovitch. Bacillus (Compt. rend. Soc. Biol., Paris, 71, 1911, 169.) From normal human intestine and

from diseased appendix.

Bacillus fibrosus Gerstner. (Thesis, Basel, 1894, 26.) From soil and sewage. Bacillus flüggei Migula. (Anaerobe No. IV, Flugge, Ztschr. f. Hyg., 17, 1891, 290; Migula, Syst. d. Bakt., 2, 1900, 597.)

From boiled cow's milk.

Bacıllus fossicularum Lehmann and Neumann. (Wasserstoffbacillus, Omelianski, Cent. f Bakt., II Abt., 8, 1902, 262; Lehmann and Neumann, Bakt. Diag., 4 Aufl , 2, 1907, 466, may bave been named in the 3 Aufl.) From mud from canals. Forms hydrogen and CO; from anaerobic cellulose iermentations.

Bacillus funicularis Gerstner. (Theals, Basel, 1894, 24.) From soil and

sen age

Bacillus gangraenae Tilanus. (Nederi. Tijdschr v. Geneeskunde, 21, 1885, 110.) From a gangrenous human leg.

Ba illus gracilis cthylicus Achaime and Rosenthal (Compt rend. See Biol. Paris, 58, 1906, 1025) From stomach con-

tents in a case of gastritis

Bacillus granulosus Gerstner. (Gerstner, Thesis, Basel, 1894, 21; Bacillus granulatus Migula, Syst d. Bakt , 2, 1900,

613 ) From soil and sewage. Bacıllus haumanı Soriano (Unnamed plectridium, Sordelliand Soriano, Compt. rend. Soc. Biol., Paris, 99, 1928, 1517, Plectridio amarillo, Soriano, Tomo commemorativo del XXV aniversario de la fundación de la Facultad de Agronomia y Vetermaria, Buenos Aires, 1929, (?); Soriano, Rev. Inst. Bact., Buenos Aires, 5, 1930, 743, Plectridium amarillum Stampa, Ann Brass et Distill , 29, 1930-31, (253, 271 and 302?); Bacillus haumannı Arnaudi, Boli Ist Sjeroter, Milaoo, 16, 1937, 650, Clostridium haumanni Prévot, Ann. Inst Past., 61, 1938, 81.) From flax-retting beds.

Bacillus ichthyismi Konstansoff (Vestnik Obshieli, Hig. Sudeb, i Prakt. Med., Petrograd, 51, 1915, (766?); quoted from Weinberg et al., Les Microbes Anaérobics, 1937, 341.) From fish responsible for a condition simulating botulism.

Bacillus indolicus Gratz and Vas. (Gratz and Vas. Cent. f. Bakt , II Abt , 41, 1914, 511; Inflabilis indolicus Prévot. Aon. Inst. Past., 61, 1938, 77.) From cheese.

Bacillus infantilism Hill and Whitcomb. (Amer. Jour. Pub. Health, 5, 1913, 926.) From human intestine.

Bacillus inflatus Koch. (Koch, Botan Zeit , 46, 1888, 328; Clostridium înflatum Trevisan, I generi e le specie delle Batteriacee, 1889, 22; not Bacillus inflatus Distaso, Ann. Inst. Past., 25, 1909, 955) Anaerobic atatus insecure: aerobic according to Kruse, in Flugge, Die Mikroorg., 3 Aufl., 2, 1896, 259. Observed in swamp waters, but not isolated Formed two apores in a spindle-shaped sporangium.

irregularis Choukévitch Bacıllus (Choukévitch, Ann. Inst. Past., 25, 1911, 348; Clostridium irregularis Prévot, Ann Inst. Past., 61, 1938, 85 ) Fmm large

intestine of horse.

Bacillus kedrowskii Migula. (Bacillus No. 2, Kedrowski, Ztschr. f. Hyg., 18, 1894, 451; Bacillus acidi butyrici Kruse, in Flugge, Die Mikroorg., 3 Aufl., 2, 1896, 256; not Bacillus acidi butyrici I Weigmann, Cent f. Bakt., II Abt., 4, 1898, Bacillus .pseudonaricula), Migula, Syst. d. Bakt., 2, 1900, 589 } From cheese and rancid butter.

Bacillus lactopropylbutyricus Tissier. (Apparently identical with Bacillus lactopropylbutyricus non liquefaciens Tissier and Gasching, Ann. Inst Past., 17, 1903, 546; Tissier, Ann. Inst. Past., 19, 1905, 282; Clostridium lactopropylbutylicum Prévot, Ann Inst Past., 61, 1938, 85; Bacillus lactopropylbutylicus non liquefaciens Prévot, Man d Class., etc., 1940, 141) From milk

Bacillus lichenoides Piening. (Cent. Bakt, I, Abt, Orig, 124, 1932, 217; not Bacillus lichenoides Grobmann, Cent f Bakt, II Abt, 61, 1924, 267) Cited only by name, without description From dried sheep intestines used for preparation of catgut sutures.

Bacillus limosus Klein (Ber d. Deutsch. Bot Gesellsch., 7 (Bhft.), 1889, 60 ) Migula (Syst, d. Bakt., 2, 1900, 640) says this is probably anaerobie. Observed in swamp water, but not cultivated on artificial media

Bacillus longus Chester. (Bacillus muscoules colorabilis Ucke, Cent f. Bakt, I Abt, 25, 1893, 1000; Chester, Man Determ. Bact, 1901, 303) From garden soil.

Bacillus lubinskii Kruse (Tetanusahnlicher Bacillus, Lubinski, Cent f Bakt, 16, 1894, 771; Kruse, in Flugge, Die Mikroorg., 3 Aufl. 2, 1806, 207.) From a fetid human abdomlinal abscess in pertonitis

Bacillus lyticus Costa and Troister. (Compt rend Soc. Biol, Paris, 78, 1915, 433) From gangrenous war wounds. Stated to be intermediate between Clostridium perfringers and Clostridium septicum.

Bacillus macrosporus Klein. (Ber d. Deutsch Bot Gesellsch, 7 (Bhft), 1889, 60) Migula (Syst d Bakt., 2, 1900, 640) says this is probably anaerobic. Observed in swamp water, but not cultivated on artificial media.

Bacillus makrono-fihformis Becker (Ztschr f Infkrakh d. Haust , £5, 1922, 20 ) From a gumea pig cadaver.

Hacillus maymone Carbone. (Boll. Sez Ital, Soc. Intern. Mierobiol, 1, 1929, 74) A retting organism of doubtful purity and anaerobic status. Cultivated from kenaf (Hibiscus cannabrus).

Bacillus megalosporus Choukévitch (Choukévitch, Ann Inst Past., 25, 1911, 351, Hiberillus megalosporus Heller, Jour Bact, 7, 1922, 17; Inflabilis megalo\*porus Prévot, Ann Inst. Past., 61, 1938, 77.) From large intestinc of horse.

Bacillus multiformis Distaso (Distaso, Cent. f. Bakt., I Abt., Orig, 88, 1911, 101; not Bacillus multiforms van Sanus, Dissert, Leiden, 1890, (7); Bacteroides multiformis Bergey, Manual, 1st ed., 1923, 263; Cilibbacterium multiforme Prévot, Ann. Inst. Fast., 60, 1938, 297.) Stated by Distaso (ide. cit.) not to produce aporcs, but to belong probably to the Welch Group. From feces of dog

Bacillus multiforms van Senus. (van Senus, Dissert., Leiden, 1890 and Koch's Jahrsber, 1, 1890, 138) From mud and from decomposing vegetation

Bacillus muscoides Liborius (Liborius, Ztschr. f. Ilyg., 1, 1886, 163, Cornilia muscoides Trevisan, I generi e le specie delle Hatteriaceo, 1889, 22.) Frommouse inoculated with soil, from cheese, and from boviue feces.

Bacillus muscoides non colorabilis Ucke (Cent f. Bakt , I Abt., 23, 1898, 1000) From hay infusion.

Bacillus nanus Romanovitch. (Compt. rend Soc. Biol, Paris, 71, 1911, 239)
From human intestine.

Bacillus nebulosus Vincent. (Ann. Inst Past st, 1007, 69; not Bacillus nebulosus Wright, Mem Nat. Acad Sci., 7, 1894, 485, not Bacillus nebulosus Hallé, Thèse de Paris, 1893, 33, not Bacillus nebulosus Migula, Syst d Bakt, 2. 1900, 844; not Bacillus nebulosus Gorscine, Jour Bact, 27, 1934, 52) From well and river water

Bacullus oedematis Migula. (Bacullus oedematis maligni Liborius, Zischr. f. Ilyg. 1, 1889, 188, not Bacullus oedematis maligni Zopl, Die Spaltpilze, 3 Auft., 1885, 83, Migula, Syst d Bakt, 2, 1900, 604; not Bacullus oedematis Chester, Man. Determ Bact, 1901, 292)

Bacillus otifidis sporogenes putrificus von Hibler. (Cent f. Bakt, I Abt., Orig, 68, 1913, 282.) From a human brain abscess.

Bacillus otricolare Weinberg and Ginsbourg. (Bacillo otricolare, Nacciarone, Riferma Med., 53, 1917, 778; Weinberg and Ginsbourg, Bull. Inst. Past., 28, 1925, 825; Endosporus otricolare Prévot, Ann. Inst. Past., 61, 1938, 75.) From

human gaseous gangrene.

Bacillus pappulus de Gasperi. (de Gasperi, Cent. f. Bakt., I Abt., Orig., 68, 1911, 1; Paraplectrum pappulum Prevot, Ann. Inst. Past., 61, 1938, 75.) From rancid sausages.

Bacillus parabulyricus Gratz and Vas. (Gratz and Vas. Cent. f. Bakt., 11 Abt., 41, 1914, 510; not Bacillus parabulyricus LeBlaye and Guggenheim, Man. Prat. de Diag. Bact., 1914, 324.) From Liptauer cheese.

Bacillus penicillatus Gerstner. (Inaug. Diss., Basel, 1894, 27.) From soil

and sewage.

Bacillus peroniella Klein. (Ber. d. Deutsch. Bot. Gesellsch., 7 (Bhft.), 1839, 60.) Migula (Syst. d. Bakt., 2, 1900, 640) says this is probably anaerobic. Observed in swamp water, but not cultivated on artificial media.

Bacillus polypijormis Liborius. (Liborius, Ztschr f. Hyg., 1, 1886, 162; Corniliu polypijormis Trevisan, I generi e le specie delle Batteriacee, 1839, 22, Annerobe No. II, Sanfelice, Ztschr, I, Hyg., 14, 1893, 309; Bacillus cephaloideus Migula, Syst. d. Bakt., 2, 1900, 631.) From mouse inoculated with sod.

Bacillus posiumus Heim, (Heim, Lehrbuch d Bakt., 3 Aufl., 1906, (?) (p. 259 in 6 Aufl.); quoted from Würeker, Sitzungsber d. Physik. Mcd. Soz. in Erbangen, 41, 1909, 230, also Heim, Cent. f. Bakt., I Abt., Orig., 55, 1910, 341.) From various spontaneously puttelying infusions.

Bacillus pseudomagnus Migula. (Anaerobe No VI, Sanfelice, Zischr. I. Hyg., 14, 1893, 373; Migula, Syst. d. Bakt., 2, 1900, 608; Bacillus caris Chester, Man. Determ Bact., 1901, 293.) From putrefying meat infusions, soil and animal evereta.

Bacillus pseudonavicula Migula. (Species No. 1, Kedrowski, Ztschr. f. Hyg, 18, 1894, 445; Bacillus acidi butyrici I Weigmann, Cent. f. Bakt., II Abt., 4,

1898, 830; not Bacillus ocidi butyrici Kruse, in Flügge, Die Mikroorg., 3 Aufl., 2, 1896, 256; Migula, Syst. d. Bakt., 2, 1990, 590.) From cheese and rancid butter.

Bacillus pseudooedematis Kruse. (Pscudo - Oedembacillen, Liborius, , Ztschr. f. Hyg., 1, 1886, 163; Bacillus pseudo-oedematis maligni Gerstner, Inaug. Diss., Basel, 1894, 35; not Bacillus pseudocedematis maligni Sanielice, Ann. dell'Ist. d'Ig. di Roma, n.s. 1, 1891, 370; Anaerobe No. VII, Sanlelice, Ztschr f. Hyg., 14, 1893, 374; Kruse, in Flugge, Die Mikroorg., 3 Aufl., 2, 1896, 239; Bacillus pseudocdematis Chester, Man. Determ. Bact., 1901, 293; presumably identical with Bacillus pseudo-septicus Perrone, Ann. Inst. Past , 10, 1905, 371, and, according to Perrone, with Proteus hominis capsulatus Bordoni-Uffreduzzi, Ztschr. f. Hyg., 5, 1888, 233 ) From mouse inoculated with soil, from putrelying meat infusions and from animal excreta

Bacillus pseudosolidus Migula. (Anaerobe No. III, Sanfelice, Zischr. I. Hyg., 14, 1893, 371; Migula, Syst. d. Bakt. 2, 1900, 639; Bacillus lardus Cheeter, Man. Determ. Bact., 1901, 294; not Bacillus tardus Choukévitch, Ann. Inst. Past., 25, 1911, 350.) From putrelying meat infusions, soil, and from animal evereta.

Bactilus preudotetani Migula. (Pseudotetanusbacillas, Tavel and Lanz, Mitt a. klin med. Inst. d Schneiz, J. 1833, 162; Migula, Syst. d. Bakt, 2, 1900, 593; Bacillus taveli Chester, Man. Determ. Bact., 1901, 304.) From cases of jutestinal abscesses.

Bacillus pseudotetanicus Kruse. (Anaerobe IX, Sanfelice, Zitschr. f. Hys. 14, 1893, 375; Kruse, in Flagge, Die Mikroorge, 3 Aufl., 2, 1896, 267; not Bacillus pseudotetanicus Mugula, Syst. d. Bakt., 2, 1900, 626; not Bacillus pseudotetanicus Chester, Man. Determ. Bact., 1901, 362; Bacillus subbitanicus Migula, loc. ctt., 629.) From putrefying mest infusions and from soil. Bacillus putrificus coaquians Distaso. (Cent f. Bakt, I Abt., Orig., 59, 1911, 97.) From human and animal intestine. Bacillus putrificus var. non liquefaciens

Putzu (Policlin., Sez. Chir., 23, 1916, 225.) From human gas gangrene.

Bacillus putrificans ammobilis Distaso (Ann Inst Past, 23, 1909, 962) From the feces of the flying fox (Pteropus)

Bacilius pyogenes foetidus Herfeldt (Cent. f. Bakt, II Abt., 1, 1895, 77)
From manure and from horse intestine

Bacillus reniformis Gerstner (Gerstner, Inaug Diss, Basel, 1894, 22, Bac-

Wchnschr, 63, 1916, 133) From human lesions

Bacullus satellitis Loris-Melikov. (Unnamed species of Loris-Melikov, Compt. rend. Sec. Biol., Parıs, 70, 1911, 885; Lorus-Melikov, Ann. Inst. Past., 27, 1913, 515, Bacıllus satelitis (sic) Loris-Melikov, Compt rend Acad Sci, Parıs, 166, 1913, 346, Infabrius satellitus Prévot, Ann Inst. Past., 61, 1938, 77) From human tyrhold feces

Bacillus scatologenes Weinberg and Ginabourg. (Skatol-liberating Clostridium, Fellers, Abst. Bact., 7, 1923,

Cent f Bakt, 11, 1892, 4, Clostridium rubellum Prévot, Ann. Inst. Past, 61, 1938, 85) From dust and dirt

Bacillus saccharofermentans de Gas peri (Compt. rend Soe Biot, Paris, 67, 1909, 494.) From putrefying earcasses of game birds.

Bacillus saccharogenes Romanovitch (Compt rend Soc Biol, Paris, 71, 1911, 168) From human intestine, both nor-

mal and during appendicitis

Bacillus saprogenes I, II and III,

Herfeldt (Herfeldt, Cent f Bakt, 11

Abt, J, 1895, 77; not Bacillus saprogenes

Salus, Arch f Hyg, 61, 1904, 115)

From manure and from horse intestine

Bacillus saprogenes intestinalis Romanovitch (Compt rend Soc Biol, Paris, 71, 1911, 237) From human intestine

Bacillus saprophyticus Maes (Surg Chin. North Amer., 10, 1930, 792) Only easual mention of this organism as one of the common gas bacilli. Otherwise unsdentified

Bacillus saproloxicus Surdelli, Soriano, Ferrariand Torino (Sordelli et al , Rev d Inst Bact., Buenos Aires, 6, 1934, 432, Clostridium saproloxicum Právot, Ann Inst. Past., 61, 1938, 83) From human gascous gangrene

Bacıllus sarcoemphysematodes hominis Conradi and Bieling (Munch med Paris, 1927, 54 ) From spoifed canned macaroni and salmon

Bacillus septicus Klein. (Klein, Micro-Organsmas and Disease, London, 1884, 78, not Bacillus septicus Macé, Tratté Prat d Baci, 1st ed, 1888, 455, not Bacillus septicus Migula, Syst. d Bakt., 2, 1000, 616) Probably synonymous with Clostridium perfurgent Type A From earth, putrid blood and other atbumnous futds, and occasionally in

blood-vessels of man and animals after

Bacillus solidus Lüderitz (Lüderitz, Zischr f Hyg, 5, 1889, 132, not Bacillus solidus Chester, Ann Rept Del Col Agr Exp Sta, 10, 1808, 120, Corniha solida Trevisan, I genera e le specie delle Batteriacee, 1889, 22) From mouse and

solida Trevisan, I generi e le specie delle Batteriacee, 1889, 22 ) From mouse and guinea pig inoculated with soil Bactilus solmsii Klein. (Klein, Ber

d Deutsch. Bot Gesellsch, 7 (Bhft.), BS9, 63, Duplectridium solmsin Fischer, Jahrb f. Wass Bot, 27, 1895, 1489, Migula (Syst d Bakt, 2, 1900, 640) says this is probably anacrobic Observed in awamp water, but not culti-

vated on artificial media.

Bacillus spinosus Lüderitz (Lüderitz, Ztschr. f Hyg., 5, 1889, 152; Cornilia

spinosa Trevisan, I generi e le specie delle Batteriacee, 1889, 22.) From mouse and guinea pig inoculated with soil

Bacillus sporogenes Migula. (Bacillus enteritidis sporogenes Klein, Cent. f. Bakt., I Abt., 18, 1895, 737; Migula, Syst. d. Bakt., 2, 1900, 560; Bacillus (enteritidis) sporogenes and Bacillus enteritidis Klein, Loc. Govt. Bd., Ann. Rept. Med. Off., London, 33, 1903-04, 442 and 443; Bacillus sporogenes capsulatus Rettger, Jour. Biol. Chem., 2, 1906-07, 84; Bacillus enteritidis-sporogenes Holland, Bact., 5, 1920, 218; Clostridium enteritidis-sporogenes Holland, thid., 218; Clostridium enteritidis sporogenes Holland, ibid., 222; Glostridium sporogenes Holland, ibid , 220.) Probably a culture of Clostridium perfringens contaminated with Clostridium bifermentans or with Clostridium sporogenes. From epidemic diarrheal feces, and from milk presumably causing the epidemic

Bacillus porogenes non liquefaciens Jungano. Gungano, Compt. rend Soc. Biol., Paris, 68, 1903-09, 716; Bacillus sporogenes liquefaciens Jungano, tôid, 718; Bacillus sporogenes non liquefaciens anaerobius LeDlaye and Guggenhein, Man Prat. d. Ding Bact., 1914, 395 ) From the intestine of the flying for

(Pleropus).

Bacillus sporagenes foetidus Choukevitch (Ann Inst Past, 25, 1911, 257) From the large intestine of a horse

Bacillus sporogenes parvus Choukévitch. (Ann. Inst Past., 27, 1913, 251.)

From intestine of cattle.

Bacillus stellatus Vincent. (Vincent, Ann. Inst. Past, 21, 1907, 09; Bacillus stellatus anaerobius LeBilaye and Guggenheim, Man. Prat. d. Ding Bact., 1914, 388; Bacterium stellatum LeBlaye and Guggenheim, idem) Anaerobie status uncertain, but Vincent compares is viih Bacillus polypiforms Liborius, and with Anaerobe No II, Sanfelsee. From water.

Bacillus subjectidus Migula. (Annerobe V, Sanfelice, Zischr I Hyg. 14, 1893, 372, Migula, Syst. d. Bakt., £, 1900, 600; Bacillus anaerobic No V Chester, Man. Determ Bact., 1901, 296; Bacillus pseudoitanieus Chester, ibid., 302.) From putrefying meat infusions, 201, and from animal exercta. Bacillus lachysporus Wesbrook. (Jour. Path. and Bact., 4; 1896-97, 8.) From infection in human tetanus.

Bacillus tenus glycolyticus Distaso. (Ann. Inst. Past., 23, 1909, 955.) From intestine of the flying fox (Pteropus).

Bacıllus tenuis spatuliformis Distaso. (Distaso, Cent. f. Bakt., I Abt., Orig., 52, 1911, 101; Bacteroides lenuis Bergy et nl., Manual, 1st ed., 1923, 203; Cillobacterium spatuliforme Prévot, Ann. Inst. Prévot, Man. d. Class., etc., 1940, 70 Spores not observed by Distaso, but placed by him in the pertringens-group. From feces of dog.

Bacillus teras Knorr. (Knorr, Cent. f. Bakt., I Abt., Orig., 82, 1918-19, 223; Inflabilis teras Prévot, Ann. Inst. Past, 6t, 1933, 77.) From soil and from fluid aspirated in hematopneumothorax.

Bacillue thalassophilus Russell. (Russell, Zischr. I. 11yg., 11, 1592, 189) Variably recorded as a strict or facultative anacrobe (see Bacillus polymyza and Bacillus spharricus). From sea nater and mud from depth of sea.

Bacillus thermofibrincolus Itano and Arakawa. (Bull. Agric. Chem. Soc., Japan, 5, 1929, 33) Source not recorded. Bacillus tumpanicuniculi Morcos.

Bacillus tympani-cuniculi Morcos. (Jour Bact., 23, 1932, 454.) From viscera, museles and blood of rabbits dying

of infectious tympanitis.

Bacillus ukilni Weinberg, Prévat, Davesne and Renard. (Unamed species of Ukil, Compt. rend. Soc. Biol., Paris, 87, 1922, 1009; Weinberg et al., Ann. Inst. Past., 42, 1928, 1193; Beallus oedematogenes Frei, Ergeb. d. silgem. Path Mensch. u. Titre, 51, 1939, 52, Clostrodium ukilni Hauduroy et al., Dict. d. Bact Path., 1937, 142; Clostridium ordematis-benigni Prévot, Ann. Inst.

Bacellus ventreulosus Roch. (Rucu, Botan Zert, 46, 1888, 341; Clostridium ventreulosus Trevisan, I generi e le specio dello Batteriacee, 1889, 22.) Probably not anaerobic. Observed in decaying vegetation and in swampy waters.

Bacterium coprophilum Migula. (Anacrobe No. 2, Sewerin, Cent I Bakt., II Abt., 9, 1807, 708; Migula, Syst d. Bakt, 2, 1900, 323; Bacillus coprophilus Weinberg, Nativelle and Prévot, Les Microbes Anaér, 1937, 643.) From horse manure.

Bacterium lini Migula. (Unnamed species of Winogradsky, Compt rend. Acad Sci, Paris, 121, 1895, 744; Migula, Syst d. Bakt, 2, 1900, 513 From retting flax

Bacterium pseudoclostridium Migula (Clostridium foctidium lactis von Freudenreich, Cent f Bakt., II Aht., I, 1895, 856, Migula, Syst d Bakt., 2, 1900, 511 \ From cheese

Bacterium sternbergii Migula (Bacillus anaerobicus liquefacieras Sternherg, Resoarches relating to the etchogy and provention of yellow fever, Washington, 1891, 2811, Bactilus anaerobicus liquefaciens Kruse, in Flugge, Dio Mikroorg, 3 Aufl. 2, 1890, 241, Migula, Syst d Bakt, 2, 1800, 444, Bacterium anaerobicum Chester, Man Determ Bact, 1901, 195) From intestine of a yellow fever coulsyer.

Battridium butyricum Chudlakow. (Chudlakow, Zur Lehre von der Annerobose, Teil I, Moskau, 1896, (?); quoted from Rothert, Cent f Bakt., II Abt. 4, 1898, 390) Stated by Rothert to be a pathogenic, obligate annerobe, but source of culture is not specific

Caduceus thermophilus a Prévot-(Anaerobie thermophile a (Thermo a), Veillon, Ann. Inst. Past , 85, 1922, 428, Prévot, Ann Inst. Past , 61, 1938, 86; Bacillus thermophilus a Prévot, Man. d Class , etc., 1910, 150, Caduceus thermophilus Prévot, ibid , 149; Caduceus thermophilus alfu Prévot, ibid , 150) From horse manure

Clostridium aceticum Wieringa (Jour-Microbiol and Serol, 6, 1930, 257.) From soil. Oxidizes II., using CO, at the hydrogen acceptor, forming acette acid, thus using II. as sole source of growth energy and CO<sub>2</sub> as sole carbon source for cell growth.

Clostridium albo-lacteum Killian and Feher (Ann. Inst. Past., 55, 1935, 620) From Sahara Desert soil

Clostridium alboluteum Killian and Fehér. (Ann. Inst. Past., 55, 1935, 595) From Sahara Desert soil.

Clostridium album liquefaciens Killian and Fehör. (Ann. Inst Past., 55, 1935, 595) From Sahara Desert soil.

593) From Sahara Desert son.

Clostridium album minor Killian and
Fehér. (Ann. Inst. Past., 55, 1935, 620)

Presumably identical with Clostridium
minor Killian and Fehér. 1bid., 597.

From Sahara Desert soil

Clostridum album non liquefaciens
Killian and Fehér. (Ann. Inst. Past.,
55, 1935, 599) Presumably identical
with Clostridium non liquefaciens Killian
and Fehér. ibid. 591 From Sahara Des-

ert soil

Clostridum americanum Pringsbeim

(Eine Alkohole bildende Bakterienform,

Pringsbeim, Cent. f. Bakt., 11 Abt., 15,

1905, 300, Bacillus pringsbeim Pringsbeim, ébad, 311, Pringsbeim, Cent. f.

Bakt, 11 Abt., 16, 1906, 790; Clostridum

bulyricum var americanum Prévot, Man.

d Class, etc., 1940, 199.) Anserobie

status uncertain, From spontaneously

Clostridium aurantibutyricum Hellinger (Commemorative Vol to Dr Cb. Weizmann's 70th Birthday, Nov., 1944, 46) From retted Hibiscus from So. Africa

fermenting potato

Clostridum balaenae Prévot. (Walfischseptikamie Bacillus, Nielsen, Cent. f. Rakt., 7, 1890, 269; Bacille de la septicémie des baleines, Christiansen, Compt. rend. Soc. Biol., Paris, 83, 120, 323; Walfischseptikamiebazillus, Christiansen, Cent. f. Bakt., I Ab, Orig., 84, 1920, 127; Prévot, Ann. Inst. Past., 61, 1933, 81.) From flesh of whales dying of septicemia. Later isolated from same material by Christiansen.

Clostridium canadiense Dernhy and Blanc. (Jour. Bact., 6, 1921, 420.) From a human case of gangrenc.

Clostridium caproicum Prévot. (Ba-

cillus anaerobicus der Capronsauregruppe, Rodella, Cent. f. Bakt., II Abt., 16, 1906, 58; Prévot, Ann. Inst. Past., 61, 1938, 84; Bacillus anaerobicus caproicus Prévot, Man. d. Class., etc., 1940, 140.) From cheese.

Clostridium cellobioparus Hungate. (Jour. Bact , 48, 1914, 499.) From rumen of cattle.

Clostridium cellulosae Horowitz-Wlassowa and Novotelnow. (Cent. f. Bakt., II Abt., 91, 1935, 477.) Cited only by name. Source not stated.

Clostridium corallinum Prévot and Raynaud. (Ann. Inst. Past , 70, 1944, 182) From serous fluid obtained post mortem from a mouse inoculated with an emulsion of street dust.

Clostridium cuniculi Galli. (Galli, Boll. Ist. Sieroter., Milan, 5, 1923-24, 337; Closiridium gallii Prévot, Ann. Inst. Past , 61, 1933, 83 ) From necrotic visceral lesion in a rabbit.

Vuillemin. disporum Clostridium (Compt. rend. Acad. Sci., Paris, 186, 1903, 1583.) Probably not anaerobic. Encountered in cultures of Blastomyces; said to form two spores.

Clostridium foetidum fecale Romanovitch. (Compt. rend. Soc. Biol., Paris, 71, 1911, 238.) From normal human

intestine

Clostridium ghoni Prévot. (Unnamed species of Ghon and Mucha, Cent f. Bakt , I Abt , Orng , 89, 1905, 497; Prévot. Ann. Inst. Past , 61, 1938, 83.) From post-operative human peritonitis.

Clostridium giganteum Benecke and Keutner (Ber. d Deutsch, Botan Gesellsch , 21, 1903, 340.) From sea water. Clostridium haemolysans Hauduroy et

al. (Bacillus anaerobius haemolysans Markoff, Cent. f. Bakt., I Abt., Orig, 77, 1915-16, 421; Hauduroy et al , Dict d. Bact Path., 1937, 105; Plectridium hemolysans Prevot, Ann Inst Past, 61, 1938, 87) From putrid human buccal

Clostridium hueppei Trevisan. tersaurebacilien, Hueppe, Mitteil a d. kais Gesundhits , 2, 1884, 353; Bacillus butyricus Flugge, Die Mikroorg., 2 Aufl., 1836, 300; Trevisan, I generi e le specie delle Batteriacee, 1889, 22: Bacillus pseudo-butyricus Kruse, in Flugge, Die Mikroorg., 3 Aufl., 2, 1896, 207; Bacillus hueppei Chester, Man. Determ. Bact., 1901, 276.) From milk. .

Clostridium hyalinum Kıllian and Fehér. (Ann. Inst. Past., 55, 1935, 595)

From Sahara Desert soil.

Clostridium kluyverii Barker and Taha. (Jour. Bact., 45, 1942, 347.) From alcohol-containing enrichment cultures of Methanobacterium omelianskii inoculated with black mud from fresh water and marine sources.

Clostridium liborii Trevisan. (Liborbuttersäurebildender Bacillus, Flugge, Die Mikroorg., 2 Aufl., 1886, 209, Trevisan, I generi e le specie delle Batteriacee, 1889, 22.) Presumably the same as Clostridium foetidum Liborius, Ztschr. f. Hyg., 1, 1886, 160. From mice inoculated with garden soil.

Henneberg. medium Clostridium (Cent. f. Bakt., II Abt , 55, 1922, 248) From human and animal feces.

Clostredium metelmans Prévot. (Ann. Inst. Past., 61, 1938, 84) Stated by Prévot to bave been isolated by Mitelman from diarrheal buman intestine.

Clostridium mucosus Simola. (Simola, Ann. Acad. Scient. Fennicoe, Helsinki, Ser. A, 34, 1931, (1157); Clostridium mucosum Prévot, Man. d. Class., etc., 1940, 112; not Clostridium mucosum Bergey et al., Manual, 4th ed., 1934, 472; quoted from Prévot, Ann Inst. Past., 61, 1938, 80 who records it as a facultative annerobe.) Source of isolation unknown.

Clostridium myzogenes Simola. (Simola, Ann. Acad. Scient. Fennicoe, Helsinki, Ser. A, 34, 1931, (115?); quoted from Prévot, Ann. Inst. Past , 61, 1938, 80 who records it as a facultative anaerobe ) Source of isolation unknown.

Clostridium necrosans Prévot cillus aerogenes necrosans Schupfer, Polician , Sez. Med , 12, 1905, 261; Prévot, Ann. Inst Past., 61, 1938, 84.) Isolated from a gaseous, necrotic thoracic abscess in a woman

Clostridium nothnageli Henneberg. (Cent. f. Bakt, II Abt, 55, 1921-22, 215) Cultivated, but not isolated in pure eulture, from human and animal feces.

Clostridium partum Prévot. (Unnamed anaerobe of Levens, Cent. f Bakt, I Abt. Orig, 88, 1922, 479, Prévot, Ann. Inst Past., 61, 1938, 85.) From a cow in post-partum rauseb-brand.

Clostridium propionicum Cardon and Barker. (Jour. Bact, 52, 1946, 629) From marine mud.

Clostridium proteolyticum Choukévitch. (Ann. Inst. Past., 27, 1913, 253) Said to bo a facultative anaerobe From intestine of cattle.

Clostridium pygmaeum Henneberg. (Cent f Bakt, HAbt, 55, 1921-22, 250) From human and animal feces.

Clostidium saroemphysematodes Prévot (Bacillus sarcemphysematodes homnus Conradi and Bieling, Münch med Wochnsehr, 63, 1916, 134, Clostrudium earcemphysematodes (sup Prévot, Ann Inst Past, 61, 1938, 81, Prévot, Man d Class, etc., 1940, (20) From human gaseous gangrene.

Clostridium sardiniensis Prévot. (Ann Inst. Past, 61, 1938, 81) Referred to Altara by Prévot. Cited by name only from Prévot.

Clostridum secundum Hauduroy et al (Unnamed species of Chon and Sachs, Cent. f Bakt, I Abt, Orig, 48, 1909, 399; Hauduroy et al., Diet. d Bact Path, 1937, 130) From human emphysematous liver.

Clostridium solidum Sanfelice. (Sanfelice, Zischir f. Hyg., 14, 1893, 372; Bacillus solidum Chester, Ann Rept Del Col Agr Erp Sta, 10, 1898, 129; Bacillus sonfelice: Migula, Syst. d Batt., 2, 1900, 630, not Bacillus solidus Lideritz, Zischir f. Ilyg., 6, 1889, 182) From putrefy ing meat infusions, soil and from animal excrete.

Clostridium sphaeraides Killian and Fehér (Ann Inst. Past , 55, 1935, 598) From Sahara Desert soil. Clestridium strasburgense Haudaroy et al. (Unnamed species of Vaucher, Boez, Lanzenberg and Kchlstadt, Bull. et Mem. Soe. Méd. Hop Paris, 49, 1925, 1611; Haudaroy et al, Diet d. Bact. Path., 1937, 133, Inflabilis sangueole Prévot, Ann Inst. Pat, 61, 1938, 77). Joslated by blood culture in human puerperal sentiemia.

Clostridium tenue Hauduroy et al (Bacillus anaerobicus tenuis Distaso, Cent. f. Bakt., I Abt., Orig., et., 1912, 439; Bacillus anaerobius tenuis LeBlaye and Guggenbeim, Man. Prat. d. Diag. Bact., 1914, 337; Hauduroy et al., Dict. d. Bact. Path., 1937, 136) From normal human intestine.

Clostridium thermocaidophilus Damon and Feirer. (Damon and Feirer, Jour. Bact., 10, 1925, 41; Palmula thermocaidophilo Prévot, Ann. Inst. Past., 61, 1938, 89, Acujormus thermocaidophilus Prévot, Man. d. Class., etc., 1940, 165 Isolated annerobically, but not strictly anerobic From horse manure

Clostridium thermoaerogenes Damon and Feirer. (Damon and Feirer, Jour Bact, 10, 1925, 40, Caduceus thermoaerogenes Prévot, Ann Inst. Past., 61, 1938, 86) From horse manure.

Clostridsum thermocellum Viljoen, Fred and Peterson (Viljoen et al., Jour. Agric. Sci (London), 16, 1926, 7; Terminosporus thermocellus Prévot, Ann. Inst Past, 61, 1933, 86) From horse manure

Clostridium thermochainus Damon and Feirer. (Jour. Bact., 10, 1925, 42.) From horse manure

Clostridum thermophilum Jemel'jantschik and Borissowa. (Microbiology (Russian), 10, 1911, 236-211; Bacillus thermophilus annerobicus, iden; abst. in Cent f. Bakt, II Abt., 105, 1942, 143; not Clostridium thermophilum Pribram, Jour. Bact , 22, 1931, 430) From fish conserves

Clostridium thermoputrificum Damon and Feirer (Damon and Feirer, Jour Bact., 10, 1925, 39; Palmula thermoputrifica Prévot, Ann. Inst. Past., 61, 1938, 89; Acuformis thermoputrificus Prévot, Man. d. Class., etc., 1940, 165.) From horse manure.

Clostridium tosinogenes Prévot. (Unnamed anaerobe of Kojima, Ztschr. f. Hyg., 99, 1923, 86; Prévot, Ann. Inst. Past., 61, 1938, 82) From muscle of a cow dying of symptomatic anthrax.

Clostridium ureolyticum Prévot. (Ann. Inst. Past., 61, 1938, 85; presumably Erde A, Geilinger, Cent. f. Bakt., II Abt., 47, 1917, 252.) From manured soil.

Clostridium ralerianicum Prévot. (Făulnisanaerobien der Baldriansaure, Rodella, Cent. I. Bakt., II Abt., 16, 1996, 62; Prévot, Ann Inst. Past., 61, 1938, 81.) From cheese.

Clostridium viscosum Chudiakow. (Zur Lehre von der Anaerobiose, Teil I, 1890 (Russ.); quoted from Rothert, Cent. f. Bakt., II Abt., 4, 1898, 390.) A facultativo anaerobe.

Clostridium zanthogenum DeGraafi. (Nederl. Tijd. Hyg, Microbiol. en Serol., 4, 1930, 219.) From cultured battermilk undergoing atypical fermentation

Clostridium zuntzii Henneberg. (Cent. I. Bakt., II Abt., 55, 1922, 240.) Cultivated, but not isolated in pure culture, from human and animal feces

Cornilia paria Trevisan. (Bacillus liquifaciens parvus Luderitz, Zischr. f. Hyg., f., 1889, 148; Trevisan, I generi e le specio delle Batteriace, 1889, 22; Bacterium parvum Migula, Syst. d. Bakt., £, 1900, 324.) From animals inoculated with carden soil.

Endosporus otricolare Prévot. (Baeillo otricolare, Nacciarone, Riforma Med , Napoli, 35, 1917, 778, Prévot, Ann. Inst. Past., 61, 1938, 75.) From gangrenous war wounds

Granulobacillus sporogenes Andre. (Granu'obacillus sp., Sommer, Deutsch. Monatschr. I. Zahnheilk, 33, 1915, 233; Andre, Ztschr. f. Hyg, 114, 1933, 412.) From infected, necrotic pulp of buman teeth.

Granulobacter lactobutyricum Bei-

jerinek. (Ferment de lactate de chaux, Pasteur, Compt. rend. Acad. Sci., Paris, 86, 1853, 416; Beijerinek, Verhandl. d. k. Akademie v. Wetensch., Amsterdam, Tweedie Sectie, Deel I, 1893, 8; Bacillus lactabutgricus Migula, Syst. d. Bakt., 2, 1900, 601; Amplobacter lactabutgricus van Beynum and Pette, Cent. f. Bakt., 11 Abt., 93, 1035, 200.) From fermenting grain mash and from soil.

Granulobacter pectinosorum Beijerinck and van Delden. (Plectridium pectinorum Stormen, Mitteil d. deutsch. Landwirts. Gesellsch., 18, 1003, 195; Beijerinck and van Delden, Arch. Néerl. d. Sci. Exactes et Nat, Ser. II, 9, 1901, 423; Bacillus pectinororus LeBlaye and Gugenheim, Man. Prat. d. Diag Bact., 1914, 321; Bacillus pectinororum Henneberg, Cent. I. Bakt., II Abt., 55, 1922, 279; Clostridium pectinororum Donker, Thesis, Delft, 1926, 145) From retting plant tissues.

Granulobacter reptans Beijerinck and van Delden. (Cent. I. Bakt., II Abt., 9, 1902, 13.) Probably acrobic or micronerophilic. From garden and other soils.

Granulobacter sphaericum Beijerinek. (Cent. f. Bakt., II Abt., 7, 1901, 568) Probably aerobic or microaerophilic. From garden and other soils.

Granulobacter urocephalum Beijerinck and van Delden. (Arch. Néerl. d. Sci. Exactes et Nat., Ser. II, 9, 1904, 423) From retting plant tissues.

Höherillus rectus Heller. (Streptobacillus anacrobicus rectus Choukévitch, Ann. Inst. Past., 25, 1911, 359; Bacillus anacrobius rectus LeBlaye and Guggenheim, Man. Prat. d. Diag. Bact., 1914, 337; Heller, Jour. Bact., 7, 1922, 17; Indabalis rectus Prévot, Ann. Inst. Past, 61, 1933, 77.) From large intestined the horse.

Hiblerilius septimus Heller. (Art VII, von Hibler, Untersuch. 3. d. Path. Anner., 1903, 3 and 406; Heller, Jour. Bact, 7, 1922, 17; Clostridium septimum Prévot, Ann. Inst. Past., 61, 1938, 64.) From spleen of a guinea pig inoculated with soil.

Inflabilis barati Prévot. (Bacille de Barat, Tissier, Compt. rend. Soc. Biol., Paris, 81, 1918, 426; Prévot, Ann Inst. Past , 61, 1938, 77.) From beer wort

Inflabilis magnus Prévot. (Streptobacillus anaerobicus magnus Choukevitch, Ann Inst Past., 25, 1911, 251; Bacillus anacrobius magnus LeBlaye and Guggenheim, Man Prat. d. Diag. Bact., 1914, 337; Prévot, Ann Inst. Past , 61, 1938, 77.) From large intestine of the horse

Inflabilia placarum Prévot (Bacillus S. Adamson, Jour Path and Bact, 22, 1918-19, 373, Prévot, Ann Inst. Past, 61, 1933, 77 ) From nar nounds.

Inflabilis pseudo-perfringens Prévot. (Presumably Bacillus L. Adamson, Jour. Path and Bact., 22, 1918-19, 372; Prévot, Ann Inst. Past., 61, 1938, 77 ) From war wounds.

Inflabilia setiensis Prévot and Ray naud (Ann Inst Past, 70, 1944, 50) I'rom oysters

Martellillus proteolyticus fieller. (Organism II, Hempl, Jour. Hyg , 17, 1918, 16, Heller, Jour Bact., 7, 1922, 26.) From muscle in human gaseous gangrene.

Myerillus sadowa Helier. (Jour Bact, 7, 1922, 7, also Barney and Heller, Arch. Surg , 4, 1922, 477 ) From a gangrenous human arm

Pectinobacter amylophilum Makronov. (Arch Sci Biol. (Russ ), 18, 1915, 441 ) Stated by author to be anacrobic, but description does not make this evident From soil

Plectridium cellulolyticum Pochon (Compt. rend. Soc Biol , Paris, 113, 1933, 1325 ) Isolated anacrobically, but not strictly anaerobic From stomach of ruminants

Plectridium pectinovorum liquefaciens Siolander and McCov (Cent f. Bakt . 11 Abt., 97, 1937, 315 and 322, probably identical with Amylobacter liquefaciens Ruschmann and Bayendamm, Cent. f Bakt., 11 Abt , 64, 1937, 359 ) From spontaneously retting plant tissues

Plectridium anieszkoi Prévot. (Unnamed anaerobic thermophilic cellulosefermenting species. Snieszko, Cent. f. Bakt , II Abt., 88, 1933, 403; Prévot. Man. d. Class, etc., 1940, 154.) From soil and manure.

Recordillus fragilis Heller. (Jour. Bact., 7, 1922, 8 and 27.) From a liver infaret in a cow.

Reglillus progrediens Heller. (Jour. Bact., 7, 1922, 7; also Barney and Heller, Areh Surg , 4, 1922, 477 ) From muscle of a gangrenous human arm

Robertsonillus primus Heller. (Organism I. Hempl. Jour Hyg . 17, 1918, 13; Heller, Jour. Bact, 7, 1922, 7) From a gangrenous war wound of human maxilla.

Streptobacillus terrae Ucke. (Cent. f. Bakt , I Abt., 25, 1898, 1000 ) From garden soil

Terminosporus raabi Prévot. (Unnamed anaerobe of Raab, Jour. Amer. Water Works Assoc , 10, 1923, 1051; Prévot, Ann. Inst Past., 61, 1938, 86) From Minneapolis city water.

thermocellulolyticus Terminosporus (Ann Inst Past., 88, 1942. 354, 383 and 467.) Strict anaerobe. Optimum growth at 60° to 66°C.

Tyrothrix catenula Duclaux. claux, Ann Inst. Nat. Agron., 4, 1882, 23; Cornilia catenula Trevisan, I generl e le specie delle Batteriacee, 1889, 22; Bucillus catenula Chester, Ann. Rept. Del Col Agr. Exp Sta , 10, 1898, 123.) Commonly regarded by anaerobic, but not by Migula (Syst d. Bakt , 2, 1900, 588). From cheese.

Tyrothrix clasifarmis Duclaux, (Duclaux, Ann. Inst Nat. Agron , 4, 1882, 23; Pacinia claviformis Trevisan, in litt. quoted from DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1017, Bacierium clasiforme Migula, Syst. d Bakt . 2. 1900. 322; Bacillus claviformis Vincent, Ann Inst. Past., 21, 1907, 70.) From cheese.

Tyrothrix urocephalum Duclaux. (Duclaux, Ann. Inst. Nat. Agron., 4. 1882, 23, Bacterium urocephalum Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 10. 1898, 123; Bacillus urocephalum Migula. Syst. d. Bakt., 2, 1900, 533.)

Appendix II. The following organisms are listed in the text as probable synonyms or possibly related species. They are cited here again in order to record the source of the original isolation. For convenience, they are listed alphabetically under the names of the species to which such presumed relationship is nacribed.

1. Clostridium butyrieum Prazmow-ski.

Amylobacter non liquefaciens Ruschmann and Bavendamm. From retting plant tissues.

Bacille amylozyme, Perdrix. From city water of Paris, and from the Seine River water.

Bacillus amylobacler S and IV Wertbeim. From soil and tissues of field

Bacillus bulylicus Fitz. From glycerol solutions undergoing butylic fermentation after inoculation with fresb cow feeces.

Bacillus holobutyricus Perdrix From

Bacillus orthobutylicus Grimbert.
From soil, grains and from legumes.
Bacillus saccharobutyricus von Klecki.

From cheese.

Bacterium naucula Reinke and Berthold. Observed and described from decomposing plant tissues Not isolated in pure culture

Bactridium butyricum Chudiakow. Cited by Rothert, and source not stated

by abstractor

Butylbacillus, Buchner From gly-

cerinated hay infusion.

Clostridium butyricum (Bacillus amylobacter) I, II, III, Gruber From sugar solutions undergoing butyric fermentation. Source of inoculum not stated. (III is probably not strictly anaerobic ) Clostridium butyricum iodophilum

Svartz. From human feces.

Clostridium intermedium Donker. From retting flax

Clostradium polyfermenticum Partansky and Henry From mud of streams and lakes and from soil Clostridium saccharobutyricum Donker. From various farinaceous materials and from soil.

Clostridium saccharopetum Partansky and Henry. From mud of streams and lakes and from soil.

Clostridium saccharophilicum Partansky and Henry. From mud of streams and lakes and from soil.

Clostridium saccharopostulatum Partansky and Henry. From mud of streams and lakes and from soil.

Clostridium tyrobutyricum van Beynum and Pette. From soil, water, milk, cheese and various farinaceous materials. Widely dispersed in nature

Ferment butyrique (Vibrion butyrique) Pasteur. Cultivated and presumably isolated from sugar solutions undergoing butyric fermentation after inoculation with yeast. Purity of cultures seriously outestioned

Granulobacillus saccharobutyricus mobilis non-liquefactons Schattenfroh and Grassberger. From milk and from soil.

Granulobacter butylicum Beijerinck From fermenting grain mash and from soil.

Granulobacter saccharobutyricum Beijerinek. From fermenting grain mash and from soil.

Granulobacter saccharobutyricus immobule nonliquefacions McCoy et al. Source of isolation not recorded.

Plectridium pectinovorum Stormer. From retting flax and hemp. Probably not strictly anaerobic

1b. Clostridium pasteurianium Winogradsky

Bacillus azoticus, Bacillus dulcilofermentans, Bacillus inulojugus, Bacillus nonpentosus and Bacillus rhamnolicus Boddy. Source of isolation not specified, other than from cultures received from various sources labeled C. pasteurtanum.

6 Clostridium septicum Ford.

Bacillus tumefaciens Wilson. From
human gaseous gangrene.

Bradsotbacillus, Nielsen From tissues and organs of sheep dying of braxy.

Walfischseptikämie Bacillus, Nielsen From whales evidently dead of septicemia resulting from harpoon wounds

9. Clostridium novyl Bergey et al Bacille neigeux, Jungano From a human case of fetid cystitis, from absects

man ease of fetid cystitis, from abacess of kidney, and from various perineal infections.

Bacillus bellonensis Sacquépée From

human gaseous gangrene.

Bacillus gigas Zeiseler and Rassfeld
From tissues of a sheep dying of a braxy-

like disease

Bacillus oedematiens Weinberg and Seguin From human gaseous gangrene Clastrodium, buhalarum, Privat. Isa-

Clostridium bubalorum Prévot. Isolated, but not named, by Kraneveld from cases of osteomyelitis of the East Indian buffalo

Gasödembazillus, Aschoff. From human gaseous edema resulting from war wounds.

11. Clastridium acetobutylicum McCoy

Bacillus butylaceticum Freiberg From grains, soil and natural waters Widely distributed in nature

Bacillus butylicus B F, Ricard From drains from slaughter houses.

Bacillus saccharobutyricus liquefacters McCoy et al. Source of isolation unknown; records only from the collection of the Dept Agric. Bact of the Univ of Wis. Beceived from a commercial laboratory

Butylobacter betae Bakonyı From beets (Beta vulgarıs) contaminated with soil.

Butylobacter sinense Bakonyi. From Jaffa oranges. Butylobacter solani Bakonyi. From

Butylobacter solani Bakonyi. Fro German potatoes.

Butylobacter zeae Bakonyı From Ilungarıan maize.

Clostridium butyricum (Prazmowski-Pike-Smyth) Pike and Smyth. From spontaneously fermenting corn rocal mash. Clostridium inverto-acetobutylicum Legg and Stiles. From soil and from plant roaterials in contact with soil.

Closiridium propyl-butylicum Muller and Legg From soil and from plant maternals in contact with soil.

Clostridium saccharo-acetobutylicum Stiles and Legg From soil and from plant materials in contact with soil.

Clastridium sacchara-acetobutylicumalpha McCoy. From soil

Clostridium saccharo-acetobutylicumbeta Arzberger From soil, rotten wood, grain, cornstalks and river mud

Clostridium sacchara-acetobutylicumgamma Arzberger From soil, rotten

wood, grain, corn stalks and river mud Clostridium saccharobutyl-acetonicum Loughlin From potato; found in soil and on plant materials grown in or near

Clostridium saccharobutylicum-gamma Izsak and Funk. From rice.

Clostridium saccharobutyl-isopropylacetonieum Loughlin. From potatoes, grains and other plant materials grown in or above soil.

Clostridium (Bacillus) tetrylium Owen, Mobley and Arroyo From soil and from roots of sugar cane.

Clostridium sporogenes Bergey et al

Bacillus putrificus rerrucosus Zeissler. From animals suffering from a Rauschbrandlike infection, later from gancrenous war wounds

Bacillus saprogenes carnis Salus. From human feces by enrichment in meat much medium

Bacillus sparogenes coagulans Debono Froro normal human intestine.

Paraplectrum foctidum Weigmann.
From cheese and milk

Reading Bacillus, Donaldson and Joyce. From gangrenous human war wounds.

20 Clostridium bifermentans Bergey et al.

et al.

Bacillus centrosporogenes Hall. From asterility test of tuberculin, from canned

spinach and from garden soil.

Racillus liquefaciens magnus Lüderitz. From mice and guinea pigs iaoculated with garden soil.

Bacillus nonfermentans Hall and Whitehead. From poisoned Africaa arrowheads.

Bacillus oedematis sporogenes Sordelli. From human gascous gangrene.

Bacillus putrificus tenuis Zeissler. From malignant edema of various acimals and from human gascous gangrene.

Bacillus sporogenes foetidus Choukévitch. From farge intestine of horse.

Clostridium foetidum Liborius. From mice inoculated with garden soil.

Clostridium foetidum carnis Salus. From human feces by earichment ia meat mash medium.

Clostridium ocdematoides Melency, Humphreys and Carp. From a case of human post-operative gascous gangrene.

24. Clostridium perfringens Holland. Bacille du rhumatisme, Achalme. Isolated by blood culture from human cases of acuto articular rheumatism.

Bacillus amylobacler immobilis Gratz and Vas. From Liptauer cheese.

Bacillus cadaseris Steraberg. From liverand kidney of a yellow fever cadaver.

Bacillus cadareris butyricus Buday From organs of human cadavers uadergoing postmortem emphyseron.

Bacillus egens Stoddard. From muscle in a fatal case of human gascous gangrene. Bacillus emphysematis maligni Wick-

Bacillus emphysemalis maligni Wicklein. From human gaseous gangrene. Bacillus emphysematis raginae Linden-

Bacillus emphysematis raginae Landenthal. From human kolpohyperplasia cystica or vaginitis emphysematosa.

Bacillus multiformis Distaso. From feces of dog.

Bacillus ovitoxicus Bennetts. From blood, tissues and organs of sheep in Australia dying of entero-toxemia.

Bacillus paludis McEwen. From intestines and viscera of sheep in the Romney Marsh in England suffering from a disease called struck.

Bacillus perfringens Veillon and Zuber. Originally isolated from pus in buman appeadicitis; later from a variety of sources.

Bacillus phlegmones emphysematosae Fraenkel. From human gaseous phlegmans; later from a variety of related conditions of human beings and animals,

Bacillus zoodysentriae hungaricus Detre. Isolated in Hungary from intestines of diarrheal pigs and lambs.

Clostridium perfringens vat. anaerogenes Hauduroy et al. An unnamed culture isolated by Grooten by blood culture from a fatal human septicemia.

Granulobacillus saccharobutyricus ummobilis liquefaciens Schattenfroh and Grassberger. Originally isolated from market milk; later from cheese, soil, water, buman and animal feess, and from various graid meals.

29. Clostridium paraputrificum Snyder.

Bacillus innutrilus Kleinschmidt.

Froro stools of newborn ialants.

Plectridium fluxum Prévot. From feces of nursing newborn infants.

Pleciridium nonum Prévot. From emphysematous muscle of an amputâted human arm.

41. Clostridium Jentoputrescens Hart

sell and Rettger.

Bacillus cadaveris sporogenes (anaerobicus) Klein. From normal intestines of man and animals.

Bazillus radiatus Luderitz. From mire and guinez pigs ir culated with garden soil.

Bacillus tetanoides (B) Adamson. From human septic and gangrenous war

43. Clostridium tetanomorphum Ber-

Bacillus fragilis Veillon and Zuber. From humaa cases of purulent appendicitis.

Bacillus ramosus Veillon and Zuber. From human cases of purulent appendicitis and from pulmonary gangrene

45. Clostridium angulosum Hauduroy et al.

Bacillus angulosus Garnier and Simon. From blood of a child suffering from typhoid fever.

61. Clostridium tertium Bergey et al. Bacillus aero-tertius Bulloch et al.

Isolated from gangrenous human war wounds. Stated to be aerobic. Bacillus gazogenes parvus Choukévitch. From large intestine of horse.

Bacillus spermoide Ninni. From soil.

# SUBORDER II. CAULOBACTERIINEAE BREED, MURRAY, AND HITCHENS.\*

(Caulobacteriales Henrici and Johnson, Jour. Bact., 29, 1935, 3; ibid., 30, 1935, 83; Breed, Murray and Hitchens, Bact. Rev., 8, 1944, 255.)

Non-filamentous, attached bacteria growing characteristically upon stalks, sometimes sessile. The stalked cells are asymmetrical in that gum, ferric hydrovide or other material is secreted from one side or one end of the cell to form the stalk. Multiply by transverse fission. In some species the stalks are very short or absent. In the latter case the cells may be attached directly to the substrate in a zoglecie mass. Cells occur singly, in pairs or short chains, never in filaments; not ensheathed. Non-sporce fortning. Typically aquatic in babitat.

### Key to the families of suborder Caulobacteriineae.

- Long axis of cell transverse to long axis of stalk; stalks dichotomously branched
   Stalks lobose, composed of gum, forming zoogloca-like colonies.
  - Family I. Nevskiaceae, p. 830.

    B Stalks are hands of ferric hydroxide,
- Family II. Gallionellaceae, p 830.
- II. Long axis of cell coincides with axis of stalk.
  - A. Reproducing by transverse fission, stalks unbranched.
    - Family III. Caulobacteriaceae, p. 832.
- III. Sessile, aspendence of cocci and short rods attached to water plants.
  A. Denosit of ferric bydroxide shout a zoorlosic mass.

Family IV. Siderocapsaceae, p. 833

As a result of discussions that have taken place since the fifth edition of the Max-Dat was issued, certain readjustments have heen made in the arrangement of the stalked bacteria. The organisms in all of the typical species are simple rigid bacteria which are like ordinary hacteria except that they develop a stalk. For this reason the group has been made a suborder of the order Eubstetriales.

Stanier and Van Niel (Jour Bact , 42, 1911, 451) emphasize the fact that the family Pasteuriaceae includes species which reproduce by methods (longitudinal fission, budding) different from those found in other groups of hacteria, and Henrici and Johnson (loc. cit., 31) state that it is at least doubtful whether these species are phylogenetically related to the other stalked bacteria. While waiting for pure culture studies and a clarification of these relationships, this family has been placed in an appendix to the suborder Caulobacterineae.

The family Siderocapsaceae has been included in the suborder as the absence of a stalk in attached forms is a natural modification. As stated by Cholondy (Die Eisenbakterien, Jena, 1926, 31-58), these bacteria are similar in morphology and physiology to those found in the family Gallionellaceae. This is an arrangement that retains all of the simple non-filamentous types of iron bacteria in one general crown.

The stalked bacteris studied by Henrici and Johnson (loc. cit.) were of fresh water origin. Bacteria of this type are found, however, equally it not more abundantly in marine habitats where they play their part in starting the fouling of underwater surfaces. ZoBell and Upham (Bull. Scripps Inst. Oceanography, La Jolla, Calisatria, Calisatri

<sup>\*</sup> Completely revised by Prof. A. T. Henrici, University of Minnesota, Minneapolis, Minnesota, December, 1938; further revision by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, July, 1916

fornia, 5, 1944, 253) summarize this attuation as follows: "Many of the bacteria found in sea water are sessile or periphytic, growing preferentially or evclusively attached to solid surfaces. The sessile habit of marine bacteria is most pronounced when they are growing in very dilute nutrient solutions such as sea water to which nothing has been added . . . Most sessile bacteria appear to attach themselves tenaciously to boild surfaces by cruding a mucilaginous holdfast. A few have stalks. Some of the sessile bacteria grow on the walls of the culture receptacle without clouding the medium itself."

The emphasis placed on the presence of a stalk by Henrici and Johnson (loc. ct.) seems artificial. In fact it may be questioned whether mere attachment by a bold-fast or otherwise is a character of fundamental importance from the taxonomic standpoint. Henrici and Johnson's arrangement of these poorly known bacteria, however, has certain practical advantages and it has therefore been retained in this edition of the Maxuat with such modifications as seem to be clearly indicated by the procress that has been made since their outline was published

The submerged slide technique as employed by Henrici (Jour Bact., 25, 1933, 277) and by ZoBoll and Allen (Proc. Soc Exper Bol. and Med., 25, 1933, 1409) has proved to be most useful for studying bacteria that live attached to a substrate.

# FAMILY I. NEVSKIACEAE HENRICI AND JOHNSON.

(Jour. Baet., 29, 1935, 4; ibid., 50, 1935, 83.)

Stalked bacteria, the long axis of the rod-shaped cells being set at right angles to the axis of the stalk. Stalks lobose, dichotomously branched, composed of gum. Multiplication of cells by transverse binary fission. Growing in zoogloca-like masses in writer or in sugar yats.

There is a single genus Nerskie.

Genus 1. Nevskla Faminizin.

(Bul. Acad. Imp. Sci., St. Pétersb., 34, N.S. 2, 1892, 484.) From the Neva River at St. Petersburg.

Description as for the family.

The type species is Nevskia ramosa Famintzin.

 Nevskia ramosa Famintzin (Bul. Acad. Imp. Sci, St. Pétersb., Ser. IV, \$4, N.S. 2, 1892, 484.) From Latin ramosus, branched.

Globular, bush-like or plate-like colonies of gummy consistency floating upon the surface of water Colonies composed of gummy material arranged in dichotomously branched stalks masing from a common base, with the bacterial cells contained in the gum, a single cell at the tip of each stalk. At times cells are set free from the stalks to start new colonies.

Rod-shaped cells set with their long axis at right angles to the axis of the hroad lobe-like stalk Cells 2 by 6 to 12 merons, containing a number of highly refractile globules of fat or sulfur

Multiplication by binary fission Not cultivated on artificial media

Source: From the aquarium in the Botanical Garden, St. Petersburg. Similar but smaller organisms found by Henrici and Johnson (Jour. Bact., 50, 1935, 63) in a jar of water from the fily pond of the University of Minnesota greenhouse in Minneapolis

Habitat: Water.

Nerskis pediculsta (Koch and Hosacus) Henrici and Johason. (Bacterium pediculstum Koch and Hosacus.
 Cent. 1. Bakt., 16, 1894, 225; Henrici and Johnson, Jour. Bact., 30, 1935, 83)
 From Latin pediculus, diminutive of pes, foot.

Composed of trusted, short, thick, sausage-like strands, often branched There strands are stalks, composed of zum.

The cells occur at the tips of the stalks and are smaller than those of Nerskia ramesa and are without internal globules. Not cultivated.

This organism is very similar to, and may be identical with, the cultivated species described and named Betabacterium vermiforme by Mayer (Das Tibi-Konsortium. Thesis, Utrecht, 1938). See p. 382.

Source. Found growing in the syrup of a sugar refinery as zooglocae.

# FAMILY II. GALLIONELLACEAE HENRICI AND JOHNSON.

(Jour. Bact., 29, 1935, 4; ibid., 50, 1935, 83.)

Stalked bacteria, the long axis of the rod-shaped cells being set at right angles to the axis of the stalks. Stalks are slender, twisted bands, dichotomously branched, composed of ferric hydroxide, completely dissolving in dilute hydroxhloric acid. Multiplication of cells by transverse binary fission. Grow in iron-bearing waters.

There is a single genus Gallionella

#### Genus I. Gallionella Ehrenberg.

(Ehrenberg, Die Infusionsthierehen, 1833, 166; not Gaillonella Bory de St. Vincent, Diet. Classique d'Hist. Nat., 4, 1823, 393, Glocenta Kutzing, Phycologia Generalis, 1843, 245; Didpmoheliz Graffith, Ann. Mag. Nat. Hist., Ser. 2, 12, 1853, 483; Spirophyllum Ellis, Cent. f Bakt., 11 Abt., 19, 1907, 502, Nodofolium Ellis, Proc. Rov. Soc. Edinburgh, 28, Part 5, 1903, 333) From nn incorrect spelling of the algal genus name, Gaillonella.

Description as for the family.

The type species is Gallionella ferruginea Ehrenberg.

### Key to the species of genus Gallionella.

- I. Cells kidney-shaped, stalks branched
  - A. Stalks siender, spirally twisted
     Cells small, stalks very slender.
    - 1. Gallionella ferruginea.
  - Cells larger, stalks broader.
  - 2. Gallionella major.
    B. Stalks thick, not definitely in spirals.
  - 3. Gallionella minor.
- II. Cells oval or round; stalks unbranched.
  4. Gallionella corneola.

1. Gailionelia ferruginea Ehrenberg (Gaillanella ferruginea Chrenberg, Vorl Mittheil, u. d. wirkl. Vorkommenn fossiler Infusionen u ihre grosse Verbreitung. Ann Phys., Ser. 2, 8, 1836, 217, Ehrenberg, Die Infusionsthierchen, 1838, 163, Melosira ochracea Ralfs, Ann and Mag Nat. His., Ser. 1, 12, 1843, 351 (quoted from Buchanan, General Systematic Bacteriology, 1925, 363); Glocotila ferruginea Kutzing, Species Algarum, 1819, 363, Didymohelix ferruginea Griffith, Ann Mag. Nat Ilist , Ser 2, 12, 1853, 438; Glososphaera ferruginia Rabenhorst, Alg. Mitteleur, no 387, Hedwigia, 8, no. 9, 1854, 43, Melosira minutula Breb , Alg Fal., 5, 42 (quoted from DeTom and Trevisan, see below), Spirulina forruginea Kirchner, Algen, Kryptngamenflora v. Schlesien, 2, 1, 1878, 250, Spirochaete ferruginea Hansgirg, Oestr. botan Ztschr , no. 7-8, 1888, 5, Spiritlum ferrugineum DeTons and Trevisan, in Saccardo, Sylloge Fungarum, 8, 1889, 1037; Chlamydothrix ferruginea Migula, Syst. d Bakt., 2, 1901, 1011, Spirophyllum ferrugineum Ellis, Cent. I Bakt., II Abt, 19, 1997, 502, Spirophyllum tenne, Nodofolium ferrujineum, Spirosoma ferrujineum and Spirosoma solenade Ellis, Proc Roy Soc. Edinburgh, 28, Part 5, 1998, 341, also sec Cent, f. Bakt, II Abt, 22, 1910, 221; Gallionella taenata Enderlein, Baktorian-Cyclogenic, Berlin and Leipng, 1925, 222)

From Latin ferreginus, from rust.
Kidney shaped bacteria, the cells 0.5
by 12 mercons, which secrete colloidal
ferrie hydroude from the concave portion of the cell, forming band-like stulks.
A rotatory motion of the cells gives rise
to a spiral twisting of the stalks.

In the older studies, the stalks were described as the organism, the minute cells at the tip having been dislodged or at least overlooked. The cells lie at the tip of the stulk, and multiply by transverse burnty fission. This gives ruse to a dichotomous branching of the stalks Stalks become very long and slender, with smooth edges.

Not cultivated in artificial media.

Habitat: Cool springs and brooks which carry reduced from in solution.

2. Gallionella major Cholodny. (Trav. Station biolog, du Dniepre Acad, des Sci. de l'Ukraine, Classe Sci. Phys. et Math., S, Livre 4, 1927.) From Latin major, larger.

Very similar to Gallionella ferruginea, but the cells are distinctly larger (1 by 3 microns), and, some cells failing to divide, reach a length of 7 microns or more. These form stalks of double the normal width

The cells contain one or more vacuoles, apparently filled with an iron compound. Source: Found in a spring in the Caucasus.

Habitat. Iron-bearing water

3 Galllonella minor Cholodny (Ber. d. deutsch Bot. Ges , 42, 1921, 35.) From Latin minor, smaller.

Cells as in Gallionella ferruginea, but stalks are shorter, thicker, encrusted with nodules of iron and not definitely band-like or twisted.

Habitat · Iron-bearing water.

4. Gaillonella corneola Dorff. (Die Eisenorganismen, Pflanzenforschung, Heft 16, 1934, 25 ) From Latin corneolus, a little horn.

Cells spherical or ellipsoidal, or lenticular in cross section, 05 by 25 to 3.0 microns.

Stalks short, unbranched, not spirally twisted, completely dissolving in dílute hydrochloric acid. Stalks slender at the base, expanded at the tip, slightly eurved, 15 to 30 microns long, attached to the substrate by a holdfast, 3 to 8 stalks arising from a single boldfast,

Habitat: Iron-bearing water.

Appendix: Additional species of Gallionella have been described as follows: Gallionella alomerata described by Naumann (Kungl Svenska Vetenskapsakad, Handl., I, 62, 1921, Part 4, 45) is not a valid species according to Cholodny (Die Eisenbakterien, Jena, 1926, 40). From the Aneboda region, Sweden Gallionella reticulosa Butkevich. (Ber.

d. Wiss. Meeresinst. Moscow, 3, 1928, 58 and 80.) From the White Sea. Gallionella sideropous described by Naumana (Kungl, Svenska Vetenskapsakad. Handl., I, 62, 1921, Part 4, 33) is not a valid species, according to Cholodny (Die Eisenbakterien, Jena, 1926, 39). From the Aneboda region, Sweden. Gallionella tortuosa Butkevich. (Ber. d wiss. Meeresinst. Moscow, 3, 1928.

57 and 79.) From the Petschora Sea.

FAMILY III CAULOBACTERIACEAE HENRICI AND JOHNSON.

(Jour. Bact., 29, 1935, 4; roid., 50, 1935, 83.)

Stalked back of the stalks.

" a long sus strate by se binary

a button-like fission The outermost cell of a pair may form a stalk before ten account is complete. Periphytic, growing upon submerged surfaces.

There is a single genus Caulobacter

Genus I. Caulobacter Henrici and Johnson.

(Jour. Bact , 29, 1935, 4; :bid., 30, 1935, 83) From Latin caulis, stalk and bacter, a small rod

Description as for the family.

The type species is Caulobacter vibrioides Henrici and Johnson.

 Caulobacter vibrioides Henrici and Johnson (Jour. Bact , 30, 1935, 84.) From Latin, like a vibrio

Cells elongated, curved, vibrio-like, with rounded ends, 07 to 12 by 20 to 2.5 microns

Growing upon firm substrates in water. Not cultivated on artificial media.

Habitat · Water.

Appendix: Henrici and Johnson (Jour Bact , 50, 1935, 62) list the following as possibly belonging in this genus

Bacillus flagellatus Omeliansky (Jour. Microbiol (Russian), 1, 1914, 21) Probably the same as the organism described by Jones (Henrici and Johnson, loc cit., 62).

Polar flagellate organism, Jones. (Cent. f. Bakt., II Abt., 14, 1905, 459) From water and sewage.

Vibriothrix tonsillaris Tunnicliff and Jackson. (Tunnieliff and Jackson, Jour. Inf Dis , 46, 1930, 12; see Henries and Johnson, loc eil, 62) From tonsil erypts See p. 219 for a different view. point regarding this species.

Six additional types are figured but not named by Henries and Johnson (loc cit, 84).

### FAMILY IV. SIDEROCAPSACEAE PRIBRAM.

(Tribe Siderocapseae Buchanan, Jour. Bact , 2, 1915, 615, Pribram, Jour. Bact., 18, 1929, 377.)

Cells spherical or evoid. Motile stages, if any, unknown. Not yet cultivated on artificial media. Thick capsules enclosing the cells become encrusted with ferric hydroxide Attached to the surface of leaves and other parts of water plants.

### Key to the genera of family Siderocapsaceae.

I. Cocci, occurring singly and in groups, and embedded in small irregular gelatinous masses. Genus I. Siderocapsa, p 833.

II. Coccobacteria, occurring in chains, and embedded in large gelatinous masses. Genus II Sideromonas, p 834.

### Genus I Siderocapsa Molisch.

(Ann. Jard. Bot. Buitenzorg, 2 Sér , Supp. 3, 1909, 29; also Die Eisenbakterien. Jens, 1910, 11.) From Greek sideres, iron and Latin capsa, box.

One to many spherical to ovoid small cells embedded in a mass of capsular material surrounded by ferric hydroxide. Best recognized by staining with Schiff's reagent Motility unknown Grow attached to the surface of water plants.

The type species is Siderocapsa treubis Molisch.

1 Siderocapsa treubtl Molisch (Aan Jard Bot Buttenzorg, 2 Sér, Supp 3, 1900, 29; also Die Eisenbakterien, Jena, 1910, 11) Named for Prof Treub, the director of the tropical garden at Buitenzorg. Java.

Cocci, 0.4 to 0.6 micron in diameter embedded in zooglocal masses surrounded by ferric hydroxide.

Deposit ferric hydroxide on the surfaces of water plants.

Source: Found attached to the roots, root hairs and leaves of water plants (Elodea, Nymphaea, Sagittaria, Salvinia.

Habitat. Widely distributed, on fresh water plants

2. Siderocapsa major Molisch (Ann. Jard Bot. Bustenzorg, 2 Sér., Supp. 3. 1909, 29; also Die Eisenbakterien, Jena. 1910. 13) From Latin major, larger

Cells colorless, coccus like short rods, 07 by 1.8 microns. A colony consists of 2 to 100 or more cells.

Similar to Siderocapsa treubii, except

that the cells are larger and the gelatinous capsule is less sharply defined.

Source: Isolated from Spirogyra sp. Habitat: Epiphytic on fresh water plants.

Appendix: Two additional species have been placed in the genus Sidero-capsa by later investigators:

Siderocapsa coronata Redinger. (Arch. f. Hydrobiol., 22, 1931, 410.) From lake water. A free floating form. Siderocapsa monoica Naumann. (Kungl. Svenska Vetenskapsakad.

Sidereensa monoica Naumann. (Kungl. Svenska Vetenskapsakad. Handl., 1, 62, 1921, Part 4, 49; quoted from Cholodny, Die Eisenbakterien, Jena, 1925, 59.) Found on Polamogton natans in Sweden. Cells occur singly.

### Genus II. Sideromonas Cholodny.

(Ber. d. deutsch. Bot. Ges., 49, 1922, 326; also Die Eisenbakterien, Jena, 1926, 55) From Greek sideros, iron and monas, a unit.

Small cocci or coccobacteria which grow in chains in gelatinous masses containing ferric hydrolide attached to thread algae, generally of the genus Conferca.

The type species is Sideromonas conferearum Choloday.

Sideromonas confervarum Cholodny. (Ber. d. deutsch. Bot. Ges., 19., 1922, 326; also Die Eisenbakterien, Jena, 1926, 55; Siderocystis confererum Naumann, quoted from Dorff, Die Eisenorganismen, Pflansenforschaug, 19ct. 16, 1934, 13.)
 From Latin, of the genus Conferea.

Coccobacteria: 0.5 to 0.6 by 0.8 to 0.9 mieron, occurring in chains embedded in gelatinous masses, 10 to 100 microns in diameter. Chains become visible when the gelatinous mass is treated with formalin followed by dilute IICI, washed in water, and stained with gentian violet or carbol fuelsin. No motility observed.

Form deposits of ferric hydroxide in the gelatinous mass surrounding the bacteria.

Source: Found on the surface of thread algae in water containing iron salts.

Habitat: Widely distributed on fresh water green algae

Appendix: Additional species of simple, sessile, non-filamentous bacteria which cause deposits of ferrie hydroxide have been described. The majority are rod-shaped bacteria and resemble Sideromonas. The bist follows:

Ferribacterium calceum Brussoff.

(Brussoff, Cent. f. Bakt., II Abt., 43, 1916, 203; Siderobacter calecum Naumann, Kungl. Svenska Vetenskapsakad. Handl., 1, 62, Part. 4, 1921, 53 and 63, Bacillus calcus De Rossi, Microbiol. Agraria e Teclnica, Torino, 1927, 993) From slime in drainage ditches at Aachen.

Ferribacterium duplez Brussoff, GRussoff, Cont. I. Bakt., II Abt., 43, 1916, 517; Sideroderma duplez Naumann, Kungl. Svenska Vetenskapsakad. Inadit., I, 62, Part 4, 1921, 63 and 63; Bacterium duplez De Rossi, Mierobiol. Agraria e Technica, Torno, 1927, 933 A non-motile, diplobacterium from water samples from Breslau (Schwentniger and Pirschamer).

Naumanniella minor Dorff. (Die Eisenorganismen, Pflanzenforschung, Heft 15, 1934, 21.) From iron-bearing spring water at Worms (Rhein).

Naumanniella neusionica Dorff. (Die Eisenorganismen, Pflanzenforschung, Hett 16, 1934, 2.) From Neuston on Tuefelsee near Freienwalde. Dorff (loc. cil.) indicates this species as the type for a new genus Naumanniella.

Siderobacter duplez Naumann. (Kungl. Svenska Vetenskapsakad Handl., I, 62, Part 4, 1921, 55) From Anchoda region, Sweden. Siderobacter lineare Naumann (loc est., 55). From Aneboda region, Sweden. The type species of the genus Siderobacter.

Sidercevecus communis Dorff (Die Eisenorganismen, Pflanzentorschung, Heft 16, 1934, 11.) Widely distributed in Germany, Finland, Russia, Sweden, Czechoslovakia and the U.S. A

Siderococcus limoniticus Dorff (loc cit.). From a swamp iron ore deposit This is the type species of the genus Siderococcus Dorff (loc cit.).

Siderocystis dupler Naumann (Kungl. Svenska Vetenskapsakad Handl, I. 62, Part 4, 1921, 43) From Aneboda region, Saeden.

Siderocystis minor Naumann (loc. cit, 43). From Aneboda region, Sweden. Siderocystis vulgaris Naumann (loc cit, 42). From Aneboda region, Sweden

The type species of the genus Siderocyclis

Sideroderma limnelicum Naumann. (Kungl. Svenska Vetenskapsakad. Handl., I, & Part 4, 1921, & 22, Ochrobium tectum Perfiliev, Verh. d Internat. Vereinigung f. theoret. u angew. Limnologie. 1925, Stutigart, 1927, quoted from Dorff, Die Eisenorganismen, Pflanzenforschung, Heft id, 1934, 18) From Ancboda region, Sweden The type species of the genus Subcroderma. Perfiliev regards this species as type for a new genus. Ochrobium.

Sideroderma rectangulare Naumann (loc. cit, 54) From Aneboda region, Saeden

Sideroderma tenus Naumann (loc. cit., 51). From Aueboda region, Sweden.

Suderothece major Naumann. (Kungl. Svenska Vetenskapsakad. Handl., I, 62, Part 4, 1921, 17) From Aneboda region, Sneden. The type species of the genus Suderothece.

Siderothece minor Naumann (loc. cit., 17) From Aneboda region, Sweden.

# APPENDIX TO SUBORDER CAULOBACTERIINEAE.

The family Pasteuriaceae included among the stalked bacteria by Henrici and Johnson (loc cit.) has been placed in this appendix as the organisms belonging to the genera Pasteuria and Blastocaults reproduce by methods of fission or hudding, or both, that are different from the methods of reproduction found in other bacteria. Further information regarding the organisms in these genera is greatly needed

FAMILY A PASTEURIACEAE LAURENT EMENO, HENRICI AND JOHNSON,

(Laurent, Compt rend. Acad. Sci., Paris, 3, 1890, 751; Henrici and Johnson, Jour. Bact , \$0, 1935, 84 )

Stalked bacteria with spherical or pear-shaped cells; if cells are clongated, long axis of cell coincides with axis of stalk. Stalks may be very short or absent, but when present are usually very fine and at times arranged in whorls attached to a common holdlast. Cells multiply by longitudinal fission or by budding, or by both Mostly periphytic, one species is parasitie.

Key to the genera of family Pasteurlaceae.

I Stalks lacking, cells sessile.

Genus I. Pasteuria, p. 836.

Il Stalks long and slender, often in whorls.

Genus II. Blastocaulis, p. 836.

### Genus I. Pasteuria Metchnikoff.

(Ann Inst Past , 2, 1888, 166 ) Named for Louis Pasteur, the French chemist and bacteriologist.

Pear-shaped cells attached to each other or to a firm substrate by holdfasts secreted at the narrow end, multiplying by longitudinal fission and by budding of suherical or ovoid cells at the free end

The type species is Pasteuria ramosa Metchnikoff.

1 Pasteuria ramosa Metchnikoff (Ann. Inst. Past , 2, 1888, 465.) From Latin ramosus, branched

Cells grow attached to each other in cauliflower-like masses, multiplying by longitudinal fission and by intracellular spores (?) which are extruded as bud-like hodies.

Habitat: Parasitic in the body cavities of Daphnia pulex and Daphnia magna.

# Genus II Blastocaulis Henrici and Johnson.

(Jour. Bact , 30, 1935, 81) From Greek blastos, bud, germ and Latin caults, stalk. Pear-shaped or globular cells attached to a firm substrate by long slender stalks with a holdiest at the base. Stalks may occur singly or may arise in clusters from a common holdfast. Growing on firm substrates in fresh water. Not cultivated on

artificial media The type species is Blastocaulis sphaerica Henrici and Johnson.

1. Blastocaulis sphaerica Henriei and (Jour. Bact , 30, 1935, 84) Johnson From Latin sphaera, sphere

Cells spherical, multiplying character-

estically by budding, often staining deeply at the free pole and faintly at the attached pole, I to 2 microns in diameter.

Habitat, Water.

Appendix: Henrici and Johnson (loc. cit., S4) figure but do not name four additional types of these organisms which they regard as additional species belonging to this genus.

Stamer and Van Niel (Jour. Bact , 42, 1941, 454) regard the following as be-

longing to this group:

Hyphomicrobium vulgare Stutzer and Hartleb (Saltpeterpilz, Stutzer and Hartleb, Cent. f. Bakt., II Abt., 3, 1897, 621; Stutzer and Hartleb, Untersucbungen uber die bei der Bildung von Saltpeter beobachteten Mikroorganismen, I Abt. Mittheil landwirtsch Inst Univ Breslau, 1898, abs in Cent f Bakt., II Abt. 5, 1899, 678

From tap water and soil. The position of this organism in relation to other Schizomyceles is very uncertain. It is regarded by Boltjes (Arch f Mikrobiol , 7, 1936, 188) as an organism which may be transitional between Schizomycetes and Phycomycetes The cells possess structures which appear to be polar flagella, but with dark field illumination show an attached thread of ultramicroscopic size Reproduction by cell division was not observed Possibly this may be by budding from the attached thread Associated with Nitrobacter spp. This is the type species of the genus Hyphomicrobium Stutzer and Hartleb

SUBORDER III. RHODOBACTERHNEAE BREED, MURDAY AND HITCHENS.\*

(Family Rhodobacteriaceae Migula, Syst. d. Bakt., 2, 1900, 1042; Breed, Murray and Hitchens. Bact. Rav., 8, 1944, 257.)

Cell's spherical, rod., vibrio, or spiral-shaped. Size of individual cells from less than i to over 20 microns. Matility, when chibited, due to the presence of polar dagella. Gram-negative so far as known. No endospores formed. Red, purple, brown or green hacterie which contain hacteriochlorophyll or discrebelenhality.

of extraneous oxidizable compounds which are dehydrogenated with the simultaneous reduction of carbon dioxide. As oxidizable substances can be used, such as sulfide, ar other reduced sulfur compounds, molecular hydrogen, alcohols, fatty acids, hydroxy- and keto-acids, etc. All can be grown in strictly anacrobic cultures when illuminated. Those members which can grow in the presence of air can also be cultured in the dark under acrobic conditions. Color depends markedly an environmental conditions; amall individuals appear coloriess unless abserved in masses. May contain sulfur globules. Described species have largely been found in fresh water habitats. Some species occur in markage babitats.

#### Key to the families of suborder Rhodobacterlinese.

- I. Purple bacteria whose pigment system consists of bacteriochlorophyll and variaus caretenoids capable of carrying out a photosynthetic metabolism.
  - A. Contain sulfur globules in the presence of hydrogen sulfide. The sulfur purple bacteria

Family I Thiorhodocene, p. 841.

- B. Do not contain sulfur globules even in the presence of hydrogas aulide. All require organic growth factors. The non-sulfur purple and brown bacteris Pamily II. Athiorhodaceae, p. 861.
- II. Green sulfur bacteria containing a pigmeat system which has the characteristics of a chlorophyllous compaund although it differs from the chlorophyll of green plants and from the bacteriochlorophyll of the purple bacteria.

Family III. Chlorobacteriaceae, p 869.

The organisms previously included in the arder Thiobacteriales Buchanan do not constitute a taxonomic entity; they represent rather a physiological concumulaty. In this sense, however, a special treatment of this group as a unit has decided advantages from a determinative point of view.

When first proposed as a systematic assemblage, the order Thiobacteria Migula (Syst. d. Bakt., 2, 1900, 1037) was intended to include the morphologically conspicuous organisms which, in their natural habitat, contain globules of sulfur as cell inclusions. Since Winogradsky (Bent. x. Morph. n. Physiol. d. Bact., I, Schwefelbacterien, 1833) had cludidated the function of hydrogen audice and of sulfur in their metabolism, the characteristic inclusions appeared linked with a hitherto unrecognized type of physiology, riz. the oxidation of an inorganic substance instead of the decomposition of organic materials. From this oxidation the sulfur bacteria derive their energy for maintenance and growth.

<sup>\*</sup> Completely revised by Prof. C. B. van Niel, Hopkins Marine Station, Pacific Grove, California, January, 1944.

Two groups of sulfur bacteria could be distinguished, one consisting of colorless. the other of red or purple organisms. The members of both groups presented an unusual morphology apart from the sulfur droplets; in all cases the individual cells were considerably larger than those of the common bacteria, while many species grew as distinctive colonial aggregates. Migula acparated these sulfur bacteria into two families, Beggiatogceae and Rhodobacteriaceae. Even at that time, however, some difficulties existed as to just what organisms should properly be considered as sulfur bacteria. Miyoshi (Jour. Coll Sci., Imp. Univ., Tokyo, 10, 1897, 143) had discovered a bacterium which forms stringers, incrusted with sulfur, in sulfur springs, but which does not store sulfur globules in its cells Although physiologically this Organism appeared to comply with Winogradsky's concept of a sulfur bacterium, the absence of the typical cell inclusions made Mivoshi decide it could not be considered as such. The problem was aggravated when Nathansohn, Beyerinck, and Jacobsen Published their studies on small, colorless, Pseudomonas-like bacteria capable of oxidizing hydrogen sulfide, sulfur, and throsulfate, and evidently dependent upon this oxidation process for their development. Morphologically these organisms have little in common with the Beggiatoaceae, they were designated by Beijerinck as species of Thiobacillus and have since been rightly considered as members of the order Eubacteriales (see p 78). Nevertheless, these organisms are physiologically in no way different from the Beggiatogeege, so that if physiology only is considered, a good case could be made out for their incorporation in the Thiobacteriales,

Furthermore, Molasch (Die Purpurhakterien, Jena, 1907, 95 pp.) described in some detail a number of hacterial appears which, in view of their characteristic pigment system, appeared elosely related to the Rhodobecteriaceae, but which develop only morganic media and are, therefore, not sulfur bacteria in the senge of Winggradsky or Migula. In stressing the importance of pigmentation Molisch combined the resulfur hacteria and the neally discovered purple hacteria into an order Rhodobacteria with the two families Thorhodoceae and Achonhodoceae. It is this grouping that has been followed in the present edition of the Manuac.

Only a very small number of typical sulfur bacteria have been studied in pure cultures. As a result the descriptions of genera and species rest mainly on observations made with collections from natural sources or ende cultures. Most investing gators have implicitly accepted differences in cell size or in colonial appearance as a sufficient justification for establishing independent species. Evidently this proce-

bacteria have established beyond a doubt that environmental conditions, such as composition of the medium and temperature, may evert a profound influence on the general morphology of these organisms. By this, it is not intended to infer that the previously proposed genera and species of sulfur bacteria should be abandoned. But it does follow that a cautious evaluation of the distinguishing features is necessary. In the absence of carefully conducted in estigations on morphological constancy and variability of most of the previously recognized species of sulfur bacteria with pure cultures grown under a variety of external conduions, the best approach appears to be a tentative arrangement of these organisms based upon those characteristics which are readily ascertamable. Urperence with this group over the past twenty years has shown that, while Winogradsky's fundamental work must remain the foundation of present taxonomic efforts, it is advasable to simplify the much more claborate classification developed by Buchanan which was followed in previous editions of this Manual.

Certain genera of sulfur purple bacteria, created by Winogradsky, will very probably be consolidated when detailed information concerning the morphology of the organisms is available. Until such time it seems, however, best to retain most of them, even though the distinguishing characteristics are not always very clear. For the benefit of those who are familiar with previous methods of classification it will be indicated where deviations have been adopted.

The non-sulfur purple bacteria (Athiorhodaceae Molisch; Rhodobacterioudae Buchanan) have been subjected to a comparative morphological and physiological study comprising more than 150 strains, among which all previously proposed genera and species are represented (Yan Niel, Bact. Rev., 8, 1644, 1-118). It has been found that the characteristics upon which Molisch based the seven genera of this group are inadequate, and a new classification with only two distinguishable genera has been proposed. This system will be followed here.

ogen ulfur

compounds other than sulfides. They are photosynthetic and are capable of growing in anaerobic culture when illuminated. The green pigment differs from the green plant chlorophylls and from the bacteriochlorophyll of the purple bacteria, but has the characteristics of a chlorophyllous compound. These are grouped in the family Chlorobacteriaceae.

#### FAMILY I. THIORHODACEAE MOLISCH

(Molisch, Die Purpurbakterien, Jens, 1907, 27; Subfamily Chromatioideae Buchanan, Jour. Bact., 3, 1918, 464; Rhodo-Thiobacteria Bavendamm, Die farblosen und roten Schwefelbacterien, Pflanzenforschung, Hieft 2, 1924, 102; Rhodothiobacteria Bavendamm, Ergeb Biol, 15, 1936, 49)

Unicellular organisms, often developing as cell aggregates or families of variable size and shape Single cells have the form of spheres, ovoids, short rods, whries, spirals, long rods or, occasionally, chains They occur in nature in environments containing sulfides and require light for their development, infra-red irradiation of a wave-length extending to about 900 milmimerons is effective. They produce a pigment system composed of green bacteriochlorophyll, and yellow and red carotenoids. As a result they appear as pale purple, brownish to deep red cell masses. Single cells, unless they are of considerable size, usually appear to be unpigmented. These are anaerobic or microaerophilic organisms, with a photosynthetic metabolism in which carbon diovide is reduced with the aid of special hydrogen donors without the liberation of molecular oxygen. Where these organisms are found in nature, hydrogen sulfide acts as a hydrogen donor, and sulfur, the first intermediate oxidation product, accumulates as sulfur droplets in the cells. Probably all members of the group can utilize a number of organic substances other than hydrogen sulfide as hydrogen donors for photosynthems. Thus they are potentially mixtoriphic.

Characterization of the genera in this group has since Winogradisty's studies (Beitrage zur Morphologie und Physiologie der Schwefelbaeterien, Leiperg, 1888) been based upon the mode of development of the cell aggregates Pure culture studies (Bavendamm, Die farblosen und roten Bakterien, I Schwefelbakterien, Pflansenforschung, Heft 2, 1924, 74 pp. y. an Niel, Arch (I. Alikrobiol.), 5, 1931, 1-112, Manten, Antonie van Leeuwenhock, 8, 1942, 164 pp.) have since shown that not only the sequence of events in the formation of the aggregates but also the appearance and form of the latter even including the size and shape of the component cells are influenced to a considerable event by environmental cenditions. This obviously easts doubt upon the usefulness of the previously used diagnostic criteria for genera and species. On the other hand, the scope of pure culture studies has not yet attained sufficient breadth to warrant the use of a different approach. As a provisional measure, Winogradsky's genera are therefore maintained. Even the larger taxonomic units must be regarded as being of tentative value only

Key to the genera of the family Thiorhodaceae.

- I. Cells usually combined into aggregates
  - A Cells grouped as regular sarcina packets
    - Genus I Thiosarcina, p 842
  - B. Cells not in sarcina packets
    - 1 Aggregates in the form of a flat sheet
      - a. Cells in regular arrangement, with tetrads as the common structural
        - Genus II Thiopedia, p 843
      - as. Cells in irregular aggregates.
        - Genus III Throcapsa, p 514.

Appendix: The following genus was formerly placed-near Thiopedia. Winogtadsky, Aligula, E. P. Smith and others disregard this genus A record is included here because of its historic interest.

### Genus A. Lampropedia Schroeter.

(Schroeter, in Cohn, Kryptog. Flora v. Schlesien, 5, 1, 1886, 151.) From Greek lampros, bright and pedion. plane.

Trevisan (I generi e lo specie delle Batteriacce, 1889, 28) and DeToni and Trevisan (in Saccardo, Sylloge Fingorum, 8, 1889, 1048) list as synonyms: Erythroconis Oersted, Nauthistorisk Tielsskrift, 2, 1840, 555; in part, Pedicoccus Lindner, Insur Diss., Berlin, 1887, 97; Thiopedia Winogradsky, Schwefelbactorien, Leippig, 1888, 85

Cells united into tetrads, forming flat, tubular masses, contain sulfur globules and bacteriochlorophyll and vellow and red extetenoids.

The type species is Lampropedia hyalina (Chrenberg) Schroeter.

- 1. Lampropola hyalina (Ehrenberg)
  Schroeter. (Gonium hyalinum Ehrenberg, Abhandl. d. Berl, Akad., 1830;
  Merismopedia hyolina Kützing, Species
  Algarum, 1830; Sareina hyalina Winter,
  in Rabenbosert, Kiryptogamen-Flora,
  Aufl., 1, 1851, 61; Schroeter, in Cohn,
  Kryptogram. Flora v. Schlesien, 3, 1,
  1880, 181; Pediococcus hyalinus Trevisan,
  I generi e le specie delle Battoriaces,
  1850, 283; Microeccus hyalinus Migula,
  Syst d. Bakt, 2, 1900, 195.) From
  swamp water and decomposing materials
  from sugar refineries.
- Lampropedia reitenbachii (Caspary)
   DeToni and Trevisan (Merismopedium reitenbachii Caspary, Schriften d physik, okon Gesellsch. zu Königsberg, 15, 1874, 101; Sareina reitenbachii Winter, in Rabenhorst, Kryptogamen-Flora, 2 Aufl., 1, 1884, 50; Pedicoccus reichenbachii (sie) Trevisan, I generi e le specie delle Batteriacce, 1889, 28; DeToni and

Trevisan, in Saccardo, Syllogo Fungorum, 8, 1889, 1018.) Found on rotting water-plants.

- 3. Lampropedia violacea (Breb.) De-Toni and Trevisan. (Agmenellum velaceum Breb., quoted from DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 3, 1889, 1919; Heriamopedia violacea Kutzing, Species Algarum, 1819, 472; Pediococcus violaceus Trovisan, I generi e le specie delle Batteriacee, 1889, 28; DeToni and Trevisan, loc. cit., 1918) From stagnant water. Common.
- 4. Lampropedia ochracea (Mettenhemer) DeToni and Trevisan. (Meramopedia ochracea Mettenheimer, Abhandl. d. Senkemberg naturlorsch. Gesellsch. in Frankf., 2, 1836-53, 41; DeToni and Trevisan, in Saccado, Sylloge Fungorum, 8, 1850, 1010.) From the yellowish slime from a well at Frankfer.

# Genus III Thiocapsa Winogradshy.

(Schwefelbacterien, Leipzig, 1888, 84) From Greek theion, sulfur and Latin capsa, container, capsule.

Cells appeared, occurring in families of irregularly arranged individuals held together in a common slime capsule. The aggregates are spread out flat on the substrate. Mischael and the colony grows, the capsule bursts, and the strate. Mischael are specifications of the colony grows, the capsule bursts, and the strate.

to that in scence of chlorophyll and carotenoid pigments, expense of the phydrogen sulfide. Under such conditions sulfur is stored in the form of globules in hydrogen sulfide.

the cells. This genus is so much like Thiothece that it is doubtful whether a distinction can be maintained.

The type species is Thiocapsa roseopersicina Winogradsky.

Key to the species of genus Thiocapsa.

- I Individual cells about 3 microns in diameter.
- 1 Thiocapsa roseopersicina
- II Individual cells about 15 mierons in diameter.
  - 2 Thiocapsa floridana.

1 Thiocapsa roseopersicina Winogradsky (Schwefelbacterien, Lenzig, 1888, 84) From Latin roseus, rose-colored and persicum, peach, ML, peachcolored

Cells, Spherical, 25 to 3 microns in diameter, occurring in families of irregularly arranged individuals held together in a common slims capsule Motility not observed. Usually a distinct rose red Stored sulfur droplets may attain a considerable size

Habitat Mud and stagnant bodies of water containing hydrogen sulfide and exposed to light, sulfur springs

Illustration Winogradsky, loc cit, Plate IV, fig 15 2. Thiocapsa floridana Uphof (Uphof,

Arch. f Hydrobiol, 18, 1927, 84; Thiocapsa minima Issatchenko, Borodin Jubilee Volume, p. 6, 1929? ) From the locality. Florida, where the organism was first found. Cells Spherical About 15 microns

in diameter. In groups of irregular eologies, each surrounded by a common eapsule, several colonies being stuck together Motility not observed.

Source: Palm Springs, Florida and Lake Sakskoje, near Eupatoria, Crimea. Habitat . Mud and stagnant water containing hydrogen sulfids and evposed to light, sulfur springs Probably ubiqui-

Blustration. Upliof, loc. cit. 83. fig VI.

Genus IV. Thiodictyon Winogradsky.

(Winogradsky, Schwefelbacterien, Leipzig, 1888, 80, Rhododictyon Orla-Jensen, Cent. f. Bakt , II Abt , \$2, 1909, 334 ) From Greek theson, sulfur and dictyon, net.

Cells rod-shaped, frequently with pointed ends, somewhat resembling spindles. Form aggregates in which the cells become arranged end to end in a net-like structure, somewhat reminiscent of the shape of the green alga Hydrodictyon The shape is not constant, cells may also form more compact masses Sometimes groups of cells separate from the main aggregate by active movements Common gelatinous capsule not observed Contain bacteriochlorophyli and carotenoid pigments; cells usually very faintly colored Capable of photosynthesis in the presence of hydrogen sulfide; the cells then store sulfur as small globules

The type species is Thiodictyon elegans Winogradsky

1 Thiodictyon elegans Winogradsky (Winogradsky, Schnefelbacterien, Leipzig, 1888, 80; Thiodictyon minus Issatchenko, Recherches sur les microbes de l'océan glacial arctique, Petrograd, 1914, 251 ) From Latin elegans, tasteful, elegant.

Rods. 1.5 to 1.7 by 2 5 to 5 meroas, or

longer just prior to cell division. Usually contain a large pseudovacuole (acrosome), leaving a rather thin protoplasmic sheath along the cell wall.

Sulfur droplets Generally quite small. and deposited exclusively in the thin pmtoplasmic layer.

Issatchenko (Études microbiologiques des Lacs de Bouc, Leningrad, 1927, 113-114) recognizes a forma minus and a forma magna, differentisted mainly by the size of the individual rods.

Habitat: Mud and stagnant water, containing hydrogen sulfide, and exposed to light; sulfur springs.

Illustrations: Winogradsky, loc. cit., Plats III, fig. 13-17.

# Genus V. Thiothece Winogradsky.

(Winogradsky, Schwefelbacterien, Leiprig, 1888, 32; Thiosphaera Miyoshi, Jour. Coll. Sci., Imp. Univ. Tokyo, Japan, 10, 1897, 170.) From Greek theion, sulfur and theke, container.

Purple sulfur bacteria which, in their growth characteristics, resemble the bluegreen alga Aphanothece. Cells spherical to relatively long cylindrical-ellipsoidal, embedded in a gelatinous capsule of considerable dimensions. Following cell size sion the daughter cells continue to secrete mucus which causes the individual bac-

the cells.

The type species is Thiothece gelatinosa Winogradsky.

1. Thiothece gelatioosa Winogradsky, (Winogradsky, Schwefelbacterien, Leipzig, 1888, 82; Thiophaera gelalman Miyeshi, Jour. Coll. Sci., Imp. Univ. Tokyo, Japan, 10, 1897, 170; Lamprogstis gelatinosa Migula, Syet. d. Bakt., 2, 1900, 1044; Chromatium sphaeroides Hama, Jour. Sci. Hiroshima Univ., Ser. B., Div. 2, Bot., 1, 1933, 158.) From Latin gelatio, freezing, indicating solidification or clumping.

Cells: 4 to 6 by 4 to 7 microns, spherical

to cylindrical. Color of individual cells, faint, often grayish-violet, or even dirty yellowish. Sulfur globules usually deposited in outermost layers of protoplasm, and cenerally small.

Habitat. Mud and stagnant water containing hydrogen sulfide and exposed to light; sulfur springs.

Hustrations. Winogradsky, loc. cit., Pl. HI, fig. 9-12; Miyoshi, loc. cit., Pl. XIV, fig. 25.

# Genus VI. Thiocystis Winogradsky.

(Schweleibacterien, Leipzig, 1888, 60.) From Greek theion, sulfur and kystis, sac,

of the diplococcus-shaped. Colonies may emerge a second of the common capsule and break up afterwards, sometimes into single swarmers, or the aggregates may split up inside the original capsule, and release small motife units or single swarmers. In pure cultures frequently developing as single cells and diplococci. Produce bacteriochlorophyll and carolenoid pigments, coloring the cell masses purplish to red. Capable of photosynthess in the presence of hydrogen sulfide, whereby elementary sulfur is formed as an intermediate oxidation product which is deposited as droplets inside the cells.

The type species is Thiocystis violacea Winogradsky.

#### Key to the species of genus Thiocystis.

Individual cells more than 2 microns in width.

1. Throcystis violacea.

II Individual cells about 1 micron or less in width.
2 Thiocustis rufa.

1 Thiocystis violacea Winogradsky (Winogradsky, Schwefelbacteren, Lepzig, 1888, 65, Planosarcina violacea Migula, in Engler and Pranti, Die naturl Pfianzenfamilien, 1, 1a, 1895, 20) From Latin violaceus, violet-colored

Cells. About 25 to 55 microns in diameter, spherical to ovoid Swarmers actively motile by means of polar flagella

Colonies Small, mande a common capaulic, containing not over 30 cells. Several such colonies form loosely arranged aggregates, most characteristically composed of about 10 to 20 colonies in a single capaule. The result is a nearly spherical songloca. In small colonies, the cells appear as rather distinct tetrads, in larger colonies, the cells become somewhat compressed and the tetrad-like strangement may be lost.

In pure cultures, the species often fails to produce the characteristic capsules, the organisms then occur as actively motile single cells or diplococci, with lattle nr no slame formation No pseudocapsules are formed

Habitat Mud and stagnant water containing hydrogen sulfide and exposed to light, sulfur springs.

Illustrations: Zopf, Zur Morphologie der Spaltpflanzen, Leipzig, 1882, Pl. V, fig. 12, Winogradsky, loc. cit., Pl. II, Fig. 1-7.

 Thiocystis rufa Winogradsky. (Schwefelbacterien, Leipzig, 1888, 65)
 From Latin rufus, red.

Cells Less than 1 micron in diameter. Color red, usually darker than in the type species When the cells are stuffed with sulfur globules, the aggregates appear almost black

The common gelatinous capsule usually contains a far greater number of closely packed individual colonies than is the case in Throcystis violacea

Habitat: Mud and stagnant water contsining hydrogen sulfide and exposed to hight, sulfur springs

Illustration: Winogradsky, loc. cit., Pl 11, fig 8.

### Genus VII. Lamprocystis Schroeter.

(In part, Clathrocystis Cohn, Bettr Biol. Pfl., 1, Heft 3, 1875, 156; in part, Cohnia

Lilis, Sulphur Bacteria, London and New Ynrk, 1932, 135) From Greek lampros, bright, shining, and kystis, sac et bladder

Purple sulfur bacteria which form more or less large aggregates of cells enclosed in a common gelatinous capsule. Individual cells spheries lo covid. Small aggregates closely resemble those of Thiocystis, even to the extent of the tetraclike arrangement of cells in the small colonics. Behavior of the large aggregates during development appears to be different; the small individual cell groups or colonies do not emerge from the stime espaule until the initially relatively compact cell mass becomes broken up into smaller clusters, these eventually forming a somewhat net-

like structure. This behavior has been ascribed to a chaoge in the mode of cell division which at first appears to take place in three perpendicular planes, and later presumably changes to a division in only two directions. Cells when free are motice by means of polar flagella. In pure culture also this type rarely, if ever, produces large aggregates with the development here mentioned as characteristic for the genus (Bavendamın, Die farblosen und roten Schwefelbakterne, Pflanenforschung, Hett 2, 1924, 78). This, along with the other similarities, makes it doubtful whether future studies will result in the retention of the genera Lamprocystis and Thiographic side by side. Produce bacteriochlorophyll and carotenich pigments, coloring the cell masses purplish-pink to red. Capable of photosynthesis in the presence of hydrogen sulfieds, storing elementary sulfur as globules inside the cells

The type species is Lamprocystis reseoperationa (Kutzing) Schroeter.

1. Lamprocystis roseopersicina (Kützing) Schroeter. (Microlog rosea Kutzing, Linnaes, 8, 1833, 371; Cruptococcus roscus Kutsing, Phycologia generalis, Leipzig, 1843, 149; Protococcus roseopersicinus Kutzing, Species Algarum, Leipzig, 1849, 196; Palmella persicina Cohn, Leonbard's Jarbb f. Mineralog., 1864, 606; Pleurococcus roseo-persicinus Rabenhorst. Flora Euc. Leipzig, S. 1868, 28; Bacterium rubescens Lankester, Quart Rev Micro. Sci., 18, 1873, 40S; not Bacterium rubescens Chester, Ann. Rept Del. Col. Agr Exp. Sta., 9, 1897, 115; Clathrocystis roseopersicing Cohn, Beitr Biol. Pfl , I, Heft 3, 1875, 157; Cohnia roseo-persicina Winter, in Rabenhorst, Kryptogamen Flora, 2 Aufl , 1, 1884, 48; Schroeter, in Cohn, Kryptogamen-Flora von Schlesien, 3, 1, 1886, 151, Planosarcina roseo-persicina Migula, in Engler and Prantl, Die natürlichen Pflanzenfam., 1, la, 1895, 20; Lankasteron rubescens Ellis, Sulphur Bacteria, London and New York, 1932,

135.) From Latin roseus, rose-colored and persicum, peach; M.L., peach-colored.

In all probability, Thioderma rubrum Miyoshi (Jour. Coll. Sci., Imp. Univ. Tokyo, Japan, 10, 1897, 170) is identical with this species.

Colls: Spherical to evoid, 2 to 2.5 microns in diameter, up to 5 microns long before cell division. Motile. Polar flagellate.

Winogradsky (loc. cit.) reports that the cells frequently contain pseudovacuoles Habitat: Mud and stagnant water containing hydrogen aulfide and exposed to hight: suffur springs

Rlustrations. Warming, Videnkish. Meddel. maturhistor. Foren., Kjöben. havn, 1876, Pl VIII, fig. 3 g; Zopl, Z Morphol d. Spattpfiannen, Leipzig, 1852, Pl. V, fig. 3, 13; Winogradsky, Schneich. Interien, Leipzig, 1838, Pl. II, fig. 9-15; Bavendamm, Die farblosen und roten Schweielbakterien, Jenn, 1924, Pl. II, fig. 3-5.

### Genus VIII. Amoebobacter Winogradsky

Leipzig, 1888, 71; Amoebomonas Orla-Jensen, From amoebo, one of the protozon character, and Greek baktron, rod.

Purple sulfur bacteria, usually occurring in aggregates composed of many individuals without a characteristic common capsule. Slime formation can, nevertheless, be observed with very small colonies. With growth of the individual cells, the capsule bursts and the cell mass slowly moves out while the bacteria remain unitedthe colonies change their shape during growth and in response to environmental influences; the individual cells appear motile and cause the movements of the entire colony. Winogradsky ascribes the coherence of the cell masses to the existence of interconnecting protoplasmic filaments between cells, but these have never hean observed, and their occurrence is extremely doubtful. It is much more probable that the bacteria are held together by mucus, though not so much of the latter is produced as to form a clearly discernible capsule.

Produce bacteriochlorophyll and carotenoid pigments. Capable of photosynthesis in the presence of hydrogen sulfide, and then store sulfur as droplets inside the cells

The type species is Amochobacter roseus Winogradsky.

Since the characterization of the genera Amoebobacter, Lamprocystis, Thiocystis, Throcansa and Throthere is based upon the arrangement of individual bacteris in a common capsule, which, from Winogradsky's descriptions of Amoebobacter and from pure culture studies with Thiocystis and Lamprocystis, has been shown to vary considerably, depending upon developmental stages and environmental conditions, it is quite possible that future investigations will show the desirability of restricting the number of genera

#### Key to the species of genus Amoebobacter.

- I Cells spherical to ovoid, about 2 5 to 3 5 microns in diameter and up to 6 microns in length prior to cell division.
  - Amoebobacter roseus
- II Cells distinctly rod-shaped, about 15 to 2 microns in width by 2 to 4 mlcrons in length 2 Amoebobacter bacıllosus.
- III Cells spherical, quite small, about 05 to I micron in diameter
  - 3. Amochobacter granula.

 Amoebobseter roseus Winogradsky (Schwefelbacterien, Leipzig, 1888, 77) From Latin roseus, roso,

Cells spherical to ovoid, 25 to 35 microns in width and up to 6 microns in length. Motile Often contain pseudovacuoles. Cell-aggregates often form transitory hollow spheres or sacks, with the bacteria occupying the periphery as a shallow layer These are reminiscent of stages in the development of Lamprocustis

Habitat Mud and stagnant water containing hydrogen sulfide and exposed to light, sulfur springs.

Illustrations, Winogradsky, toc est. Pl. 111, fig I-6.

2 Amoebobacter bacillosus Winogradsky. (Winogradsky, Schwefelbacterien, Leidzig, 1888, 78: Thioderma roteum Mayoshi, Jour. Coll. Sci., Imp. Univ.

Tokyo, Japan, 10, 1897, 158) From Latin bacillus, resembling a rod.

Cells rod-shaped, about 1.5 to 2 mierons by 2 to 4 microns Cells contain pseudovacuoles (acrosomes). globules deposited exclusively in peripheral protoplastate layer, usually quite

Habitat Mud and stagnant water, containing hydrogen sulfide and exposed to beht: sulfur springs

Illustrations Nopf, Z. Morphol. d Spaltofl., Leipzig, 1882, Pl. V. fig. 26-27: Winogradsky, loc cit., Pl. III, fig. 7.

Miyoshi's incomplete description of Thiodsema rossum (loc. cit), type species of genus Thioderma, is sufficient to make practically certain that at is identical with Imoebobacter bactllosus. The description of Thiodiction elegans Winogradsky (loc cit ) suggests that it cannot be distinguished from this species.

 Amoebobacter granula Winogradsky. (Schwefelbacterien, Leipzig, 1883, 78.)
 From Latin granulus, a granule.

Cells: Spherienl, small, about 05 to 1 micron in diameter. Faint pigmentation; the sulfur inclusions give the cell masses a black appearance. Aggregates are apt to consist of closely-knit masses which are difficult to separate.

When sulfur is stored, a single droplet

usually fills most of the cell Because of the high refractive index of this globule, it becomes difficult if not impossible to make accurate observations of the cell shape.

Habitat: Mud and stagnant water containing hydrogen sulfide and exposed to light; sulfur springs.

Illustration: Winogradsky, loc cit., Pl. III. fig. 8.

### Genus IX. Thiopolycoccus B'inogradsky.

(Winogradsky, Schwefelbaeterien, Leipzig, 1883, 70; Rhodopolycoccus Orla-Jeusen, Cent. f. Bakt., II Abt., 22, 1909, 331.) From Greek theion, sullur; polys, many; and kolkos, granule or small cell.

Purple sulfur bacteria which form dense aggregates of rather solid construction and irregular shape. The colonies appear, in contrast with Amoebobacler, non moitle and do not tend to form holiow coopleant structures by which they are differentiated from Lamprocystis. Cell masses held together by mucus which does not, however, appear as a regular capsule. Large clumps may fissure with the formation of irregular shreds and lobes which continue to break up into smaller groups of cells Individual bacteria spherical, motifity not observed. Contain bactericehlorophila and carotenoid pigments, so that the aggregates, in accord with the dense packing with individual cells, appear distinctly red. Capable of photosynthesis in the presence of hydrogen sulfide, when the cells store elementary sulfur as droplets inside the cells.

The type species is Thispolycoccus ruber Winogradsky.

 Thtopolycoccus ruber Winogradsky. (Minogradsky, Schwefelbaetenen, Leipzig, 1888, 79; Microeoccus ruber Migula, in Engler and Prantl, Die natürlichen Pflantenfamilien, f, 1a, 1895, 18) From Latin ruber, red.

Cells. Spherical, about 12 microns in diameter. No motility observed. Habitat: Mud and stagnant water containing hydrogen sulfide and exposed to hight, sulfur springs.

Hlustrations: Winogradsky, loc. cd., Pl. IV, fig. 16-18; Issatchenko, Recherches sur les microbes de l'océan glacial arctique, Petrograd, 1914, Pl. II, fig. 7.

3.20

### Genus X. Thiospirillum Winogradsky.

Sci

u teenn his acropse, bakterien, Jena, 1924, 115.) From Greek theion, sullur, and unmandere

Purple sulfur bacteria, occurring singly, as spirally wound cells, motile by means of polar flagella Contain bacteriochlorophyll and carotenoid pigments, coloring of polar flagella Contain bacteriochlorophyll and carotenoid pigments, coloring of polar flagella Contain bacteriochlorophyll and carotenoid pigments, coloring of polar flagella Contain bacteriochlorophyll and carotenoid pigments, coloring of the colo

The differentiation of species in this gloup ....

tions with material from natural collections and from laboratory mass cultures. The criteria used are the size and shape of the spirals, and the color of the organisms Not a single representative has so far been obtained and studied in pure culture, so that no information is available concerning the constancy or variability of these characteristies. It is, however, likely that such properties may be greatly influenced by environmental factors. Hence, the following key and descriptions of species are apt to be modified when more extensive studies have been made. The published descriptions of some species make it seem probable that they should not even be incorporated in Thospirillum.

The type species is Thiospirillum genense (Ehrenberg) Winogradsky

#### Key to the species of genus Thlospirillum.

- I. Width of cells 2.5 microns or more
  - I. Color of cells, especially in masses, yellowish-brown to orange-brown

    1. This mirillum innerse.
  - 2 Color of cells deep red or violet
    - a. Cells long, typical spirals, clearly red
    - a. Cens long, typical spirals, cicarly red

      2 Thiospirallum sanguineum
    - ga. Cells short, slightly curved, vibrio-shaped, color purple to violet-red
- 3. Thiospirillum violaceum.
  II. Width of cells less than 2.5 microns.
- 1. Width of cells 1.5 to 2 5 microns.
  - 2 Width of cells about 1 micron
- 4 Thiospirillum rosenbergii
- 5 Thiospirillum rufum

1. Thlospitillum jenense (Ehrenberg) Winogradaky (Ophidomons genenise Ehrenberg, Die Infusionstierehen, Leipzig, 1838, 44; Spirillum jenense Trevisan, Batter, ital, 1879, 26, Winogradsky, Schwefelbacterien, Leipzig, 1888, 104; Modelhospitillum jenense Lihis, Sulphur Bacteria, London and New York, 1932, 161; Thospirillum crassum Hama, Jour. Sci. Hiroshuma Univ., Ser B, Div 2, Bot., 1, 1933, 157) Named for the city of Jena, Germany, where Ehrenberg discovered this organism.

Cells Cylindrical, sometimes pointed at ends, 25 to 4 nucrons long, coiled as spirals. Generally 30 to 40 microns in length but may be as long as 100 microns. Shape of individual coils varies, complete turns measuring about 15 to 40 microns in length, and from § to 1/10 of the width in height. Polar flagellate Tufted at both ends. Olive-brown, sepia brown and reddish-brown.

This coloring appears to be the only recognizable difference from Theospir-llum sanguneum Thiospirillum crassum Ilama (fee et ) reported to be 37 to 4 by 12 to 40 meterons and yellowshirown in color, thus becomes indistinguishable from Thiospirillum generate, the 80 microns long Theospirillum jenerae forma maxima Szafer (Bull Acad See Cracover, Sér B., 1910, 162) does not at present justify recognition as a special taxonomic entity

It is even doubtful whether the observed color difference between Thiospirillum jenense and Thiospirillum sanguineam constitutes a valid criterion for their maintenance as two distinct species (Buder, Jahrb. wiss Bot, 52, 1915, 531, Bavendamm, Die farblosen und roten Schwelelbakterien, Pflanzenforschung. Heft 2, 1921, 136.

Habitat. Mud and stagment water containing hydrogen sulfide and exposed to light, more rarely in sulfur springs.

Illustrations: Zettnon, Ztschr. f. Hyg., 24, 1897, Pl. II, fig. 49-52; Buder, loc. cit., fig. 1; Szafer, loc. cit., Pl. IV, fig. 4; Hama, loc. cit., Pl. 18, fig. 1, 8a; Pl. 19, fig. 1.

2. Thiospirillum sanguineum (Ehren-(Ophidomonas Winogradsky. sanguinca Ehrenberg, Verhandl. Akad. Wiss. Berlin, 1810, 201; Spirillum sanquincum Cohn, Beitr. Biol. Pfl., 1, Heft 3, 1875, 163; Winogradsky, Schwefelbacterien, Leipzig, 1888, 104.) From Latin sanguineus, blood-colored, red.

Cells: Cylindrical, sometimes attenuated at ends, spirally coiled; 2.5 to 4.0 microns in width, commonly about 40 microns long with a range of from 10 to 100 microns. Size and shape of coils variable, complete turns measuring from 15 to 40 microns in length and from 1 to 1/10 nf the length in width. Polar flagellate, usually tufted at both ends. Individual cells rose-red with a grayish hue, groups of cells deep red. Sulfur droplets numerous under appropriate conditions.

Habitat: Mud and stagnant water containing hydrogen sulfide and exposed to light, rarely in sulfur springs.

Illustrations Cohn, loc. cit , Pl. VI, 15, Warming, Vidensk naturlust. Foren, Kjöbenhavn, 1876, Pl. VII, fig S, Buder, Jahrb wiss Bot, 56, 1915, 534, fig. 2

3 Thiospirillum violaceum (Warming) violaceum (Spirillum Winogradsky Warming, Vidensk Meddel. naturhist. Foren , Klobenhavn, 1876, 395; Winogradsky, Schwefelbacterien, Leipzig, 1888, 104 ) From Latin rolaceus, violetcolored.

Cells Short and fat, 3 to 4 by 8 to 10 microns, ends smoothly rounded. Slightly curved, bean- or vibrio-shaped Only rarely are they twisted suggesting a spirillum. Polarly flagellated.

The shape of cell seems to fit the genus Chromatium rather than Thiospirillum and Warming (loc. cit.) emphasizes the resemblance to Chromatium okenii.

Color bluish-violet: this color may be related to a secreity of sulfur droplets in the cells.

Habitat: Mud and stagnant water. Illustration: Warming, loc. cit., Pl. VII, fig. 3.

4. Thiospirillum rosenbergii (Warming) Winogradsky. (Spirillum rosenbergii Warming, Vidensk. Meddel, naturhist. Foren., Kjöbenhavn, 1876, 316; Winogradsky, Schwefelbacterien, Leipzig, 1888, 104.) Named for the Danish algologist, Rosenberg.

Cells: 1.5 to 2.5 by 4 to 12 microns; coiled, with turns of about 6 to 75 mierons in length and variable width up to 3 or 4 microns. Color very dark, due to numerous sulfur globules. Color of protoplasm not recorded.

Habitat: Mud and stagnant water containing hydrogen sulfide and ex-

posed to light.

Distribution: Probably ubiquitous, but less frequently recorded as the organism is not as spectacular as the large Thiospirillum generate and Thiospirillum sanguineum.

Illustration: Warming, loc. cit., Pl. X,

fig. 12.

5. Thiospicillum refam (Perty) Migula. (Spirillum rufum Perty, Bera, 1852, 179; Migula, Syst d. Bakt. 2, 1900, 105)) From Latin rufus, red, reddish. General characteristics presumably

those of the genus, although it does not appear either from Perty's description, or from those of Miguia (Inc. cit.), Bavendamm (Die farblesen und roten S-haefelbakterien Jena, 1924, 132) and Huber-Pestalozza (Die Binnengewässer, 16, Heft 1, Das Phytoplankton des Süsswassers, Stuttgart, 1938, 334) that the cells ever contain sulfur globules. Only the red color is emphasized Conscquently, it is quite possible that this organism belongs in the genus Rhodo-

Cells: 1.0 by 8 to 18 microns; coiled to occupy 13 to 4 turns, the latter commonly 4 microns wide by 4 microns long. These dimensions agree with those of Rhodospirillum rubrum (Esmarch) Molisch and the identity of the two organisms is probable

Habitat: Found in red slime apots on the side of a well. Mud and stagnant bodies of water

Illustration. Migula, Syst d Bakt, 1, 1897, Pl III, fig 7

Appendix: Three species have been placed in the genus Thiospirillum without convincing evidence that they conform to the generic diagnosis

Thiospirillum agilis Kolkwitz (Kolkwitz, Kryptogamenflora d. Mark Brandenburg, 5, Pilze, 1909, 162, Thiospira geilis Bayendamm. Die farblosen und roten Schweselbakterien, Psianzenforschung, Hest 2, 1924, 116.) This is not known to have been a purple bacterium and hence may represent a member of the genus Thiospira.

Throspirillum agilis var. polonica Strzeszewaki. (Bull. Acad Sci., Cracovic, Sér. B, 1913, 322.) This also may belong in the genus Thiospira

Thiosparallum pastense Czurda. (Cent f Bakt, II Abt, 92, 1935, 99) Not described as pigmented and does not contain sulfur globules. Reported to be a probable agent in the production of hydrogen sulfide from sulfates or sulfur. It may therefore be the spirillar form of Vibro desulfuream Beijeinch, or, being thermophilic, of Vibrio thermodesulfuream Finen.

Thiospirillum winogradskii Omeliansky (Cent f. Bakt, II Abt, 14, 1905, 764.) This is colorless and is included in Thiospira

#### Genus XI. Rhabdomonss Cohn .

(Cobn, Beitr Biol Pfl, 1, Heft 3, 1875, 167; Mantegazzaea Trevisan, R. Inst. Lombardo de Sci e Lett, IV, Ser 2, 12, 1870, 137; Rhabdochromatium Winogradsky, Schwefelbacterien, Leipzig, 1883, 100, in part, Rhadocapza Molisch, Die Purpurbakterien, Jena, 1907, 17.) From Greek rhabdos, a rod, and monas, a unit (cell)

Purple salfur bacterna, as a rule occurring singly, in the form of rather irregular, long rods to filaments, exhibiting more or less pronounced swellings, or club and spindle shapes. Filamentous structures aometimes with constrictions giving the filament the appearance of a atring of beads. These may be surrounded by a relatively inconspicuous slime capsule which can be rendered visible by India ink. The less distorted cell types are frequently mottle, flagella polar. Produce bacterio-chlorophyll and carotenoid pigmenta, coloring the cells pinkish to purplish-red.

larity of its members to species of Chromatsum and the occurrence of many inter-

Impér. Bot. St. Pétersb., 5, 1903, 116), van Nial (Arab. (Although) & 1921 (Although

Rhabdockromatium as abnormal growth for .

damm (Die farblosen und roten Schwefelbakterien, Pflanzenforschung, Heft 2, 1924, 120) favor generie rank.

The type species is Rhabdomonas roscus Cohn.

### Key to the species of genus Rhabdomonas.

- Cells not containing calcium carbonate inclusions in addition to sulfur globules a. Cells more than 3 microns in width.
  - 1. Rhabdomonas rosea.
  - an. Cells less than 3 microns in width.
- 2. Rhabdomonas gracilis.
- Cells containing calcium carbonate ioclusions in addition to sulfur globules.
   Rhabdomonas linzbaueri.
- 1. Rhabdomonas rosea Cohn. (Cohn, Beitr. Biol. Pfl., 1, Heft 3, 1875, 167; Beggiataa roseo-persienna Zopf, Z. Morphol. d. Spaltpflanzen, Leipzig, 1882, 30; Rhabdochromatium roseum Winogradsky, Schwefelbacterien, Leipzig, 1888, 100; Rhabdochromatium fusiforme Winogradsky, dud., 102; Pseudomonas rosra Migula, in Engler and Peantl, Die natürlichen Pflanzenfant, I, 1a, 1893, 30.) From Latin roseux, rose-colored.

Cells: Uneven in width and length. often swollen to spindle-shaped, sometimes tending towards filamentous The greatest width of a growth. spindle-shaped or fusiform cell may be close to 10 microns, in the more filamentous structures it is usually around 5 microns The length varies between 10 and 30 microns for single cells, filamentous forms, frequently showing bulges and constrictions suggestive of compound structures in which cell division has been incomplete, may attain considerably greater lengths, up to 100 microns. The ends of spindle-shaped cells often taper to very fine points or attenuated fibers; also filaments are generally thinner toward the extremities. Single individuals and short filaments are motile by means of polar flagella, long filaments rarely motile. The ends of a filament may become purched off and swim away.

Color rose-red, cells are usually filled with sulfur globules

There is no good reason for maintain-

ing Rhabdomonas fusiformis (Rhabdochromatium fusiforme Winagradsky) as a separate species; the variations in size and shape bring this form well nithin the range of Rhabdomonas rosea. Present indications strongly suggest that the latter species should be regarded as a peculiar developmental form of Chromatium obesit.

Habitat: Mud and stagmant water containing hydrogen sulfide and exposed to light; sulfur springs.

Illustrations: Cohn, loc. cit., Pl.YI, fig. 14; Warming, Vidensk Meddel naturhistor. Foren, Kjöbeahavn, 1876, Pl. VII, fig. 1c-c; Zopf, loc cit., Pl. V, fig. 2b; Winogradsky, loc. cit., Pl. IV, fig. 9-11, 13-14.

2. Rhabdomonas gracilis (Warming)
Migula. (Monas gracilis Warming,
Vidensk, Meddel, naturhist, Foren,
Kjöbenhavn, 1870, 331; Rhabdochromatuum minus Winogradsky, Schnefelbacterien, Leipzig, 1888, 102, Rhobdochromatium pracite Miguh, Syst. d.
Bakt., 2, 1900, 1049, Rhodocapas usspensa Molisch, Die Purpurbskterien,
Jena, 1907, 17; Rhabdomonas mnor
Bergey et al., Manual, 3rd ed., 1930,
523) From Latin gracilis, slender.
523 From Latin gracilis, slender.

Cells. Much smaller than those of Rhabdomonas rosea, and with less tendency to form fusiform cells. Usually filamentous, more or less cylindrical, often with constrictions, but found up to 60 microns in length. Shorter flaments motile. Polar flagellate. Slime formation may occur under special conditions. Rose red. Sulfur globules. Probably an abnormal growth form of Chromotium virosum.

Habitat Mud and stagnant watercontaining hydrogen sulfide and exposed to light, sulfur springs

Illustrations: Warming, loe cit, Pl. VII, fig 5; Winogradsky, loe cit., Pl IV, fig 12, Molisch, loe cit, Pl II, fig. 11-12

3 Rhahdomonas linsbaueri (Gicklhorn) comb nov. (Rhabdochromatum linsbaueri Girklhorn, Red deut bot Ges, 59, 1921, 312.) Named for the botanist. K. Linsbauer.

Cells Resemble Rhabdomonas rosea,

irregular, red-shaped, 3 to 5 microns wide, up to 30 microns in length.

The characteristic feature of the species, and the chief means of differentiation, is the occurrence of calcum carbonate inclusions in addition to the sulfur globules in the cells. Whether this is strictly an environmentally conditioned characteristic, due to the photosynthetic development of the bacteris in a medium rich in calcium ions, so that calcium carbonate is precipitated as the alkalmity increases, has not yet been established, but seems possible. In that case the identity of this species with Rhabdomonas roses would become evident

Source From a pond near Graz, Austria.

Habitat: Fresh water.

### Genus XII. Rhodothece Molisch.

(Die Purpurbakterien, Jens, 1997, 19) From Greek rhodon, rose and theke, container, capsulo

Purple sulfur bacteria, occurring singly, not aggregated in families. Cells apherical, each surrounded by a rather wide capsule which is, however, rarely visible without special staining. Mottly not observed Contain bacteriochlorophyll and carotenoid pigments, coloring the cells reddish. Capable of photosynthesis in the
presence of hydrogen sulfide; the cells then store sulfur globules, arising as an
intermediate oxidation product of the sulfide

In view of the experiences of Bavendamm and others that a number of representatives of the purple sulfur bacteria, characterized by typical colonial aggregates when found in nature, may develop as single cells in pure culture, it is quite conceivable that the genus Rhodothece is synonymous with some other genus, e.g., Lamprocystis, and that the two genera represent different growth forms induced by environmental conditions.

The type species is Rhodothece pendens Molisch

 Rhodothece pendens Molisch (Die Purpurbakterien, Jena, 1907, 19) From Latin pendeo, to be suspended

Cells Spherical, frequently occurring as diplocotic, occasionally as very short chains or clumps of 3 to 5 individuals 18 to 25 micross in diameter. Produce rather abundant slime Cells embelded in individual capsules which are rarely visible without staining (India inb). Characteristic is the regular occurrence of revelob scules. (accomed) which

sre supposed to keep the cells suspended in liquid media. Refractive phenomena due to the pseudovacuoles and to the sulfur globules distort the cell shape under ordnary illumination so that bacteria appear as polygons rather than round cells. Usually 2 acrossomes and 2 sulfur globules per cell. Color not observable in individual bacteria Cell groups are rowe-red. Motility not observed

Habitat Mud and stagnant water con-

talning hydrogen sulfide and exposed to light. Not reported from sulfur springs.

Illustrations: Molisch, Die Purpurbakterien, Jena, 1907, Pl. II, fig. 13-14

# Genus XIII. Chromstlum Perty.

(Perty, Zur Konntnies linies and Jensen, Cent. [ ]

last-mentioned are often thick-cylindrical with rounded ends. Motile by means of polar flagella. Contain bacteriochlorophyll and carotenoid pigments, coloring the cells various shades of red. Capable of photosynthesis in the presence of hydrogen auditide and storing elementary auliur as an incomplete oxidation product in the lorm of globules inside the cells.

At present, the genus contains 11 described species and one variety. In addition, two more purple sulfur bacteris, Preudomonas molischis Bersa (Planta, £, 1260, 375) and Thiospirillum cocincum Hams (Bour. Sci. Hiroshima Univ., Ser. B, Div. 2, Bot., 1, 1933, 183), have been incorporated here as species of Chromatium because the descriptions and illustrations furnished by the original authors leave no doubt as to their taxonomic affiliations.

Differentiation of species has, in the past, been based almost entirely upon size and shape of individual cells, often with complete disregard for the variability of these criteria. The unsatisfactory and arbitrary nature of such a classification has occasionally been pointed out, and with much justification. Winogradsky (Schwelelbacterien, Leinzig, 1888, 99) mentions the many transitional stages that can be observed between Chromatium okensi and Chromotium weissei; Strzeszenski (Bullet. Acad. Sci., Cracovie, Sér. B, 1913, 321) holds that it is impossible to distinguish, on the basis of sizes or otherwise, between Chromatium weisser and Chromatium minus. Such contentions, derived from observations on material from natural collections of crude cultures, have been greatly strengthened by studies with pure cultures of species of Chromatium. Thus van Niel (Arch. f. Mikrobiol., 5, 1931, 59) reported variations la width from 1 to 4 microns, and in length from 2 to 10 microns or even un to 50 microns; Manton (Antonio van Leeuwenhoek, 8, 1942, 164 ff.) found size differences of 1 to 14 microns with a pure culture of an organism that he identified as Chromatium okensi. Often the differences in size of a pure culture can be related to special environmental conditions. On account of such results a des gnation of species on the basis of size relations alone is manifestly unsatisfactor. Moreover, the available data do not auggest that differences in shape, color or arra igement of sulfur globules can be used more effectively. Lack of adequate experies atal results with a sufficiently large number and variety of pure cultures prevents a more rational classification at present.

The previously proposed apecies have been fisted below with their respective characteristics and arranged as far as possible in the order of decreasing width.

Two Chromatium species have been described as containing inclusions of calcium carbonate in addition to sulfur globules. As in the case of Rhabbono as linesture; it is not known a hether this feature may be a direct consequence of the calcium ion content and pli of the environment, and thus fail to have taxonomic significance.

The type species is Chromatium okenti Perty.

 Chromatium gobii Issatchenko. (Recherches sur les microbes de l'océan Named for Prof. X. Gobi. Cells: 10 microns by 20 to 25 microns. Source: From sea water of Arctic Ocean.

Habitat: Presumably ubiquitous in the colder portions of the Ocean at least. Illustration: Issatchenko, loc cit., Pl. II. fig. 12.

2 Chromatium warmingil (Cohn) Migula (Monas warmingil Cohn, Beitr. Biol Pfl, I., Heft 3, 1875, 167; Migula Syst d Bakt, 2, 1900, 1048.) Named for the Danish botanist, Eugene Warming

Cells 8 by 15 to 20 microns, also smaller (Cohn).

Illustration: Cohn, loc. cit., Pl VI, fig. 11

2b. Chromatium warmingii forma minus Bavendamm. (Die farblosen und roten Schwefelbakterien, Pflanzenforschung, Heft 2, 1924, 127) Named for the Danish botanist. Eugene Warming.

Cells. 4 by 6 to 10 microns.

Illustrations: Bavendamm, loc cst., 91, fig 7, and Pl II, fig 12, a-b.

3 Chromatium linshaueri Gickihorn. (Ber d deut. botan Ges., 59, 1921, 312) Named for the Austrian botanist, K Linshauer

Cells. 6 by up to 15 merons (Greklhorn), 6 to 8 merons in width (Ellis, Sulphur Bacterra, London and New York, 1932, 147) Special characteristic is the occurrence of calcium carbonate inclusions Otherwise resembles Chromatium obenii

Source From a pool in the Stiftingtal, near Graz, Austria.

Habitat: Fresh water.

Illustrations: Gicklhorn, loc ett, 314, fig 1, Ellis, loc ett., 148, fig. 31.

i Chromatium okenii (Ehrenberg) Perty (Monas okenii Ehrenberg, Infusionsthierchen, Leipzig, 1838; Perty, Zur Kenntniss kleinster Lebensformen, Bern, 1852, 174; Bacillus okanii Trevisan, I generi e le specie delle Batteriacce, 1859, 18; Bacterum okenii DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 6, 1859, 1027; Psaudomonas okenii Migula, in Engler and Frantl, Die naturlichen Pflanzenfamilien, 1, 1a, 1895, 30) Named for the German naturalist, L. Oken This is the type species of genus Chromotium.

Cells: 56 to 6 3 by 7.5 to 15 microns (Colon); minmum width 4.5 microns (Issatchenko, Borodin Jubilee Vol., 1929; 8); with many transitions to Chromatum verissei (Winogradsky, Schwefelbacterien, Leipzig, 1833, 93). Also. 3 5 by 8 to 12 microns and varying in size from 1 to 15 microns (Manten, Antonie van Lecuwenbock, 8, 1942, 164). Antonie van Lecuwenbock, 8, 1942, 164).

Illustrations: Cohn, Beitr Biol, Pfl, I, Heit 3, 1875, Pl VI, fig. 12, Winograds, ky, loc ett, Pl. IV, fig 3-4, Issatchenko, Recherches sur les microbes de l'océan glacial arctique, Petrograd, 1914, Pl. II, fig 9.

5 Chromatium weissel Perty. (Perty, 2ur Kenntuss kleinster Lebensformer, Bern, 1823, 174, Bacillus weisssi Trevisan, I genen ele spece delle Batteriacee, 1859, 18, Bacterium wrisin DeTom and Trevisan, in Saccardo, Sylloge Fungorum, 3, 1883, 1027.) Named for the scologist, J. F. Weisse, consequently the more common spellings, Chromatium weissis of C. weissi are in error.

Cells. 4.2 by 5.7 to 11.5 microns (Ferty); also 3 to 4 by 7 to 0 microns (Issatchenko, Borodin Jubilee Volume, 1929), 8); transitions to Chromatium okenti (Wingerdsky, Schwefelbacteren, Leipzug, 1888, 92); transitions to Chromatum minus (Strzeszenski, Bull. Acad Sci., Cracovic, 86r. B. 1913, 321).

Hlustrations Winogradsky, loc. cit, Pl IV, fig. 1-2; Miyoshi, Jour. Coll. Sci., Imp. Univ. Tokyo, Japan, 10, 1897, Pl. XIV, fig. 15. 6. Chromatium cuculliferum Gicklhorn. (Cent. f. Bakt., II Abt., 50, 1920, 419.) From Latin cucullus, cap or hood and fero, to bear.

Cells: 4 by 6 to 8 microns (Gicklhorn); according to Bavendamm (Schwefelbakterien, Jena, 1921, 127) dentical with Chromatium warmingis forma minus. Gicklhora claims this organism to be colorless, which appears very doubtful.

Source: From the pond in the Annen Castle Park, Graz, Austria.

Habitat: Fresh water ponds.

Illustration: Gicklhorn, loc. cit., fig. 2.

 Chromatium minus Winogradsky. (Winogradsky, Schwefelbacterien, Leipzig, 1888, 99; Baullus minor Trevisan, I generi e le specie delle Batteriacee, 1880, 18; Bacterium munus DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1027) From Latin minus, small.

Cells. 3 by 3 5 to 7 microns (Winogradky); also 1.7 to 3 microns in width and up to 8 5 microns in length (Issatchenko, Borodin Jubilec Volume, 1929, 9); all transitions to Chromatium vectors from which it cannot be distinguished (Streezewski, Bull Acad Sci, Cracovic, Scr B, 1913, 3215).

Illustrations. Winogradsky, loc. ct., Pl. IV, fig. 5; Miyoshi, Jour Coll Sci, Imp. Univ. Tokyo, Japan, 10, 1837, Pl XIV, fig. 16, Issatchenko, Recherches ur fes microbea de l'océan glacial arctique, Petrograd, 1914, Pl. II, fig. 10-11.

8. Chromatium vinosum (Ehrenberg) Winogradsy (Monas rinosa Ehrenberg, Die Infusionstierchen, Leipzig, 1838, 11; Winogradsky, Schwefelbacterien, Leipzig, 1888, 93; Bacilus

> vinoardo.

Syllogo Fungorum, 8, 1889, 1021.) From Latin vinosus, pertaining to wine, winecolored Cells: 2 by 2 5 to 5 microns; also 1.4 to 3 by 1.5 to 5 microns (limbo, Botan Magaz, Tokyo, 5t, 1937, 872); 1.7 to 2 by 2 to 9 microns (Issatchenko, Bordan Juhitee Volume, 1929, 9); or 1 to 13 microns by 2 5 to 3 microns (Schramacek, Beitr. Biol. d. Pfanzen, 22, 1935, 317). Junbo considers Thioderna roseum Microsito to be identical with Chromatum rinasum.

Hustrations: Winogradsky, lec. cit, Pl. IV, 6-7; Miyoshi, Jour. Coll. Sci, Imp. Univ. Tokyo, Japan, 10, 1837, Pl XIV, fig. 17; Nadson, Bull. Jard Imp. Botan, St. Pétersbourg, 12, 1912, Pl. III, fig. 1-2.

9. Chromatium violaceum Perty. (Zur Kenntniss kleinster Lebensformen, Bern, 1852, 174) From Latin violaceus, violet-colored.

Cells: About 2 by 2 to 3 microns. According to Cohn (Beitr. Biol. Pfl., 1, Hett 3, 1875, 166) probably identical with Chromatium vinosum. Apparently includes various sizes.

10. Chromatium molischii (Berss) comb nov. (Pseudomonas molischii Berss, Planta, 2, 1926, 375) Named for the Austrian botanist, H. Molisch.

Cells. About 2 by 2.5 to 8 microns-Supposedly contains calcium carbonate as inclusions

Illustration: Bersa, loc. cit., 376, 6g 3

11 Chromatium gracile Strzeszenski. (Buil Acad Sci., Cracovie, Sér. B, 1913, 321.) From Latin gracilis, slender

Cells: 1 to 1 3 by 2 to 6 microns; also to 15 micron in width (Issatchenko, Études microbiologiques des Lacs de Boue, Leningrad, 1927, 114).

Hustration: Strzeszewski, loc. ct., Pl. XXXIX, fig. 1-2; Tokuda, Botan-Magaz, Tokyo, 50, 1936, 339, fig. 1-23.

12. Chromatium minutissimum Winogradsky (Winogradsky, Schwefelbacterien, Leipzig, 1888, 100, Bacillus minulissimus Trevisan, I generi e le specie delle Batteriacee, 1889, 18, Bacterium minulissimum DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1028) From Latin minutus and diminutive. very minute

Cells: About 1 to 12 micron by 2 microns. Also from 05 to 07 micron by 0 ft 0 1 micron (Issatchenko, Recherches sur les microbes de l'océan glacial arctique, Petrograd, 1914, 253); and 1 to 3 microns by 2 to 5 microns (Issatchenko, Borodin Jubilee Volume, 19297, 9)

Borodin Jubilec Volume, 19297, 9)

Illustrations. Winogradsky, loc cit,

Pl IV, fig 8; Miyoshi, Jour. Coll Sci,

Imp Univ , Tokyo, Japan, 10, 1897, Pl. XIV, fig 18.

Appendix: The measurements for Thiospirulum coceneum Hama (Jour. Sci. Huroshima Univ, Ser. B, Div. 2, Bot., 1, 1933, 153) which, according to description and figures (ibid., Pl 18, fig. 2; Pl. 19, fig. 2), is an unquestionable species of Chronatium, are given as 2 by 4 to 15 microns It thus closely resembles the bacteria of the Chromatium minus, C vinosum, C. violaceum, and C. moluxchi group:

Chromatium sphaeroides Hama, loc. cit. Thiospirillum violaceum (Warming) Winogradsky is probably also a member of this assemblage.

### APPENDIX TO FAMILY THIORHODACAE

Three genera of sulfur purple bacteria have been proposed whose place and nature are at present very doubtful. They follow here-

a Thiospharion Miyoshi, with the single species Thiospharion violaceum Miyoshi (Jour. Coll. Sci., Imp Univ. Tokyo, Japan, 10, 1579, 170) Occurs in round colonies in which numerous bacteria are held together by mucus, though not in a clearly discertable common capsule Individual cells ovoid, about 15 to 2 by 25 microns, motile Resembles Lamprocysist reacceptsicina in many respects Reported one from Yumoto Hol Springs, near Nikko, Japan.

Illustrations: Miyoshi, loc cit, Pl

b Pelechromatism Lauterborn, with the single species Pelechromatism resum Lauterborn (Verhandl naturhist mediian Verens, Heidelberg, NF 15, 1915, 424) Forms small colonies in which the bacteria are regularly arranged in about 5 rows, from 2 to 4 cells high, around a coloriess central body. The entire colony actively motife and behaves like a single unit. Individual cells bean or vibrio-shaped, about 1 mieron or less by 2 microns, the barrelshaped colony measures 25 to 4 by 4 to 8. microns. The structure may represent a complex of a colorless central bacterium aurrounded by purple bacteria, analogous to Chlorochromatium eggraputum Lauterborn. Whether such structures have geneno or even specific favonome significance romains to be determined The lack of information concerning the occurrence of sulfur globules in the cells makes it doubtful whether the organisms are sulfur purple bacteria at all Found twice by Lauterborn in mud samples.

Illustrations: Lauterborn, loc. cit, Pl. III. fig. 28, a-c.

Utermöhl suggested the name Lauterborntade mainéa Utermöhl (Bol Zéntralbi ,43, 1921, 603) for the small brownish baeterna which form the covering of the central body of Pelodromatium roseum, according to this author the central body is a larger bacterum, 1.5 by 7 merons which he named Endosoma polleum.

e. Thioporphyra Ellis, with the single species Thioporphyra volutans Ellis (Jour. Roy. Technic. Coll Glasgow. 1926, 165). The account of this pleomorphic organism, which is claimed to multiply by fission, budding, and probably spore formation, is wholly unconvincing. The shape and size of some of the cells make it appear likely that Ellis observed maxtures of various kinds of purple sulfur bacteria.

Illustrations: Ellis, loc. cit., 166, fig. 1-14; 171, Micro. 1; 172, Micro. II; Sulphur Bacteria, London and New York, 1932; 153, fig. 33; 154, fig. 34; 156, fig. 35; 158, fig. 36.

Finally, there exist some, as yet unnamed, red to purple hacteria which contain bacteriochlorophyll and carotenoid pigments, are capable of photosynthesis

in the presence of hydrogen sulfide, but excrete elementary sulfur as an intermediate oxidation product instead of storing sulfur globules inside their cells (van Niel, Arch. f. Mikrobiol, 3, 1931, 63). They are small motile rods, vibrios or spirilla, about 0 5 by 1 to 2 microns They may also occur as spherical cells of about 1 micron in diameter. They can readily be grown in organic media. under anaerobic conditions, in illuminated cultures and may be included either with the sulfur purple bacteria or with the non-sulfur purple bacteria, among which Rhodopseudomonas palustris is equally capable of photosynthesis in the presence of reduced inorganic spi fur compounds

#### FAMILY II. ATHIORHODACEAE MOLISCH.\*

(Molisch, Die Purpurbakterien, Jena, 1907, 28; Rhodobacterioideae Buchanan, Jour. Bact., 3, 1918, 471; Athiorhodobacterin Bavendamm, Ergeb. Biol., 13, 1936, 49.)

Unicellular bacteria, of relatively small sire, occurring as spheres, short rods, vibrios, long rods and spirals. Motility is due to the presence of polar flagella Gram-negative. They produce a pigment system composed of bacteriochlorophyll and one or more carotenoids, coloring the cells yellowisb-brown, olive brown, dark brown or various shades of red. Color usually not observable with single cells but only with cell masses. Generally microactophilie, although many representatives may grow at full atmospheric nygen tension. Capable of development under strictly anaerobic conditions, but only in illuminated cultures by virtue of a photosynthetic metabolism. The latter is dependent upon the presence of extraneous hydrogen donors, such as alcohols, fatty acids, hydroy- and keto-acids, and does not proceed with the evolution of molecular oxygen. Those members which can grow in the presence of air can also be cultivated in darkness, but only under aerobic conditions.

Key to the genera of family Athlorhodaceae.

I Cells rod-shaped or spherical, not spiral-shaped

Genus I. Rhodopseudomonas, p. 861.

II. Cells spiral-shaped

Genus II Rhodospirillum, p 866.

Genus I Rhodopseudomonss Kluyver and van Niel emend, van Niel.

(Includes Rhodobacillus Molisch, Die Purpurbakterien, Jena, 1907, 14; Rhodobacterium Molisch, ibid., 16; Rhodococcus Molisch, ibid., 20; Rhodoubrio Molisch, ibid., 21; Rhodocysius Molisch, ibid., 22; Rhodorskoe Molisch, ibid., 23; Rhodophacra Buchanan, Jour Bact, 25, 1918, 472; Rhodorskoe Molisch, ibid., 23; Rhodorskoe Sist, Rhodomonas Kluyver and van Niel, Cent. f. Bakt., II Abt, 94, 1938, 397; not Rhodomonas Orla-Jensen, Cent. f. Bakt., II Abt, 24, 1900, 331; Kluyver and van Niel, in Czurda and Maresch, Arch f. Mikrobiol, 8, 1937, 110, van Niel, Bact. Rev., 8, 1944, 80) From Greek rhodon, red and pseudomonas, lalse unit.

Sphereal and rod-shaped bacteria, motile by means of polar flagella. Gramnegative. Contain bacteriochlorophyll which enables them to carry out a photosynthetic metabolism. The latter is dependent upon the presence of extraneous oxidirable substances and proceeds without the evolution of molecular oxygen. Though some members can oxidize inorganue substrates, none appears to be strictly autotrophic, due to the need for special organic growth factors. Produce accessory pigments eausing the cultures, especially when kept in light, to appear in various shades of brownish-yellow to deep red.

The genus includes the members of Mohsch's genera Rhodobacterium, Rhodobacillus, Rhodosibrio, Rhodocystis, Rhodonostoc and Rhodococcus, as well as the genera Rhodosphacra Buchsnan, Rhodorrhagus Bergey et al. and Rhodomonas Kluyver and van Niel.

The type species is Rhodopseudomonas palustris (Molisch) van Niel.

Completely revised by Prof. C B. van Niel, Hopkins Marine Station, Pacific Grove, California, January, 1944.

# Keys to the species of genus Rhodopseudomonas.

- I. Based upon morphological characters.
  - 1. Cells clearly rod-shaped in all media.
    - a. Cells short, somewhat curved, to long branched rods, size of young and short cells 0.6 to 0.8 by 1 2 to 2 microns; in older cultures up to 10 mierons long; do not form slime; liquid cultures, when young, or after shaking, evenly turbid. Color red to dark brown-red.
      - 1. Rhodopseudomonas palustris.
    - aa. Cells slender rods, 0.5 by 1.2 microns usually clumped together in extensive slime masses. Cultures pale brown to peach-colored.
      - 2. Rhodopseudomonas gelatinosa.
  - 2. Cells more or less spherical in media at pH below 7.
    - a. In media at pH about 7 clearly rod-shaped, 1 by 1 to 2.5 microns. Chains of cells frequent, and in characteristic zigzag arrangement.
      - 3. Rhodopseudomonas capsulatus.
      - aa. In media at pH above 7 cells still predominantly spherical, 0.7 to 4 mierons in diameter. Mostly single, little tendency to chain formation, 1. Rhodonseudomonas spheroides
- II. Based chiefly on physiological properties.
  - 1. Gelatin liquefied
  - 2. Rhodopseydomonas gelatinosa.
  - 2. Galatin not liquefied.
    - a Does not produce mucus in media at pH above 8. Color the same under serobic and anserobic conditions of growth.
      - 1 Rhodopseudomonas palustris.
    - as. Produce mucus in media at pH above 8. Color brown in anaerobic, red in aerobic culture.
      - b. Develops readily in media with 0 2 per cent propionate as the chief oxidation substrate. Mucus production marked at pH above 8, but very limited between 7 and 8.
        - 3. Rhodopseudomonas capsulatus.
      - bb. Does not develop in media with 0 2 per cent proponate as the main oxidation substrate Slime formation extensive at pH above 7.
        - 4. Rhodopseudomonas spheroides.
- III. Based principally upon biochemical characters.
  - Thiosulfate used as main oxidation substrate.
    - 1. Rhodopseudomonas palustris.
  - Thiosulfate not used.
    - a. Propionate (0 2 per cent) used.
      - 3. Rhodopseudomonas capsulatus.
    - aa. Propionate not used.
      - b Manutol and sorbitol (0.2 per cent) used.
        - 4. Rhodopseudomonas spheroides.
      - bb Mannitol and sorbitol not used.
        - 2 Rhodopseudomonas gelatinosa.

1 Rhodopseudomonas palustris (Molisch) van Niel. (Rhodobacellus palustras Molisch, Rhodobacterium capsulatum Molisch and Rhodovibro parvus Molisch, Die Purpurbskterten, Jena, 1997, 13, 18 and 21, Rhodomonas palustrus Kluyver and van Niel, Cent. f Bakt, II Aht. 94, 1936, 297; Rhodopseudomonas No 9 and No 16, Czurda and Maresch, Arch 1 Mikrobiol., 8, 1937, 120; van Niel, Baet Rev , 8, 1944, 83) From Latin paluster, boggy, marshy

Cells: Usually distinctly rod shaped. though in young cultures very short, lightly curved rods may often predominate. Size variable, even for the same strain, and strongly influenced by age of culture and composition of medium Rather consistently short cells in young cultures in yeast extract, especially when incubated anacrobically in the light, or in anaerobic cultures with substrates which permit only a slow and scanty dovelopment, such as malonate Dimensions in such cultures 0 6 to 0 8 by 1 2 to 2 microns More often, especially in older cultures, cells are much longer. up to 10 microns Highly characteristic is the pronounced tendency to the formation of irregularly shaped, bent and crooked long rods, occasionally swollen at one or both extremities, and frequently suggesting branching. Such cells usually form clusters reminiscent of Corynebacterium and Mycobacterium cultures.

Cells in young cultures actively motile by means of polar flagella, irregular and long cells as a rule non-motile Gramnegative.

Growth in liquid media never mucoid, sediment in older cultures homogeneous and smooth, readily redispersible

Color Varies considerably, depending upon the medium, and especially in anaerobic illuminated cultures. Where development is slight (as in malonate, thosulfate, and, usually, flyered inedia), the color is a light pink; in fatty acid-containing media more nearly dark reddish-brown. Color due to bacterio

chlorophyll and a number of different carotenoid pigments, most strains produce in addition a water-soluble, noncarotenoid, blush-red pigment which diffuses into the culture medium.

In yeast extract cultures growth is possible over the range pH 6 to 8.5. With certain substrates, especially fatty acids, the combined effect of low pH and a substrate concentration of 0.1 to 0.2 per cent may prevent growth. No characteristic odors save that old cultures may develop a distinct jonone-like fragrance. Gelatin is not liquisfied; leucine is generally utilized as a substrate

Most strains are able to grow on the surface of agar plates or slants; a few, especially when first isolated, appear more sensitive to ovygen and develop only in stabs in which the upper region may remain free of growth. Cenerally such strains can be adapted to grow at full atmospheric oxygen tension.

Most fatty aculs and hydroxy acids are adequate ovidation substrates. All cultures can grow at the expense of thiosulfate and produce rapid and profuse growth in glutarate and ethanol media. No development in media containing as the chief orudation substrate 0 2 per cent sorbitol, glucose or mannose, even though these substances are not inhibitory. Molecular hydrogen can be outdired.

All cultures can develop anaerobically in illuminated cultures by photosynthesis

Temperature optimum generally rather lugh, good development being possible up to 37°C. However, certain strains exhibit a lower temperature optimum.

Distinguishing characteristics: Morphological resemblance to species of Mycobacterium in old cultures, ability to grow with thosulfate as the chief ordizable substrate, and failure to develop in media which contain carbohydrates or sugar alcohols in a concentration of 0.2 per cent as the mun oxidizable compounds

Habitat: Regularly found in mud and stagnant bodies of water.

Hustrations: Molisch, loc. cit., Plate I, fig. 1, 2; Plate II, fig. 10; van Niel, loc. cit., fig. 1-3, p. 18, and fig. 18-20, p. 90.

Rhodopseudomonas gelatiaosa (Molisch) van Niel. (Rhodocystis gelatinosa Molisch, Die Purpurbakterien, Jona, 1907, 22; van Niel, Bact. Rev., 8, 1914, 95.) From Latin gelatio, freezing, indicating solidification, or in this case, elumping.

Cells: In young cultures, short and small rods, approximately 0.5 by 1 to 2 mierons. In old cultures much longer. up to 15 microns, and then irregularly curved rods, often swollen and gnarled In places up to I mieron in width. In this stage the cells bear some resemblance to those found in old cultures of Rhodopscudomonas palustris, but the characteristic Mucobacterium like chisters of the latter are absent. Single cells infrequent due to a conjous mucus production in all media which causes the cells to clump together While young cells are actively motile by means of polar flagella, motility is often difficult to ascertain as a result of the pronounced tendency to conglomerate; the individuals in the clumps appear to be non-motile Gram-negative. is liquefied, of the single amino acids alanine, asparagine, aspartic and glutamic acids appear generally satisfactory substrates.

Color: Quite distinctive in most anacrobic cultures as a pale, delicate, pinkish shade, rather peach-colored Only in the presence of rather high concentrations of yeast extract (when a much heavier growth is obtained thau with low concentrations supplemented with 0.2 per cent of various single oxidation substrates) do the slimy cell masses appear a dirty, faded brown Color is due to bacteriochlorophyll and carotenoid pigments Occasionally a water-soluble, non-carotenoid, bluish-red pigment is produced which diffuses into the culture medium.

In yeast extract, growth occurs over a pH range extending from at least 6.0 to 8.5.

Cultures produce a characteristic acrid odor.

More sensitive to fatty acids than other species of Rhodopreudomonas; with 0.2 per cent propionate no growth occurs. The beat single oxidizable substitate appear to be ethanol, glucose, fructose and mannose, as well as a variety of amino neids. Citrate also permits good growth; not, on the other hand, glycerol, mannitol, sorbitol or tartrate in the usual concentration of 0.2 per cent

Thiosulfate is not oxidized; behavior towards molecular hydrogen unknown

More pronouncedly microacrophile than the other Rhodopsewiomonas species; most cultures cannot develop on acrobically incubated shaats or agar plates.

Capable of strictly anaerobic development in illuminated cultures by virtue of a photosynthetic metabolism.

Temperature relations so far unknown. Distinguishing properties: The small site of the individual cells, and the pronounced clumping which causes the cultures to be exceptionally stringy; the unusual color of the cell masses; the ability to liquefy gelatin, to utilize ditrate and a number of amino actis Correlated with these is the failure to grow in media with 0.2 per cent propionate, bartrate and givered

Habitat: Regularly present in stagnant bodies of water and in mud.

Hustrations: Molisch, loc. cit., Plate I, fig. 8; van Nicl, loc cit., fig. 55-60, p 99; fig 61-66, p. 100

3. Rhodopseudomonas capsulatus (Molusch) van Niel. (Rhodonosioc copulatum Molisch, Die Turpurbakterien, Jena, 1907, 23; van Niel, Baet. Rev., 8, 1944, 92.) From Latin capsula, container (sheath).

Cells: Depending upon the pII of the medium, cells nearly spherical, or as distinct rods, often devoid of motility. Motility due to polar flagella spherical cells are found in media with a pH below 7; they are usually arranged in chains resembling streptococci Rodshaped cells are characteristic for media with pH above 7; the higher the pH, the longer the rods Individual cells slightly less than I micron wide, although attenuated rods (about 0.5 micron in width) are frequent at pH above 8, and slightly swollen cells (to 1 2 microns) are found in media containing sugars Length varies from I to 6 microns, most common dimensions in approximately neutral media 2 to 25 microns above 8 abnormal growth in the form of irregular filaments. Outstandingly characteristic is the zigzag arrangement of the cells in cliains

Cultures in media of pH 8 or above are distinctly mucoid Gram-negative

Color Anacrobic cultures develop with a brown color, the shade renging from a light yellowish-brown to a deep mahogany brown. When grown in the presence of oxygen, the cultures are dark red. Even the pigmentation of the brown-colored organisms from an anacrobic culture can be changed into a distinct red by slaking a suspension with air for some hours, light enhances the rate of this color change. Color due to bactericaliotophyll and carotenood pigments. No diffusible water-soluble pigment is produced.

Growth possible over a pH range from at least 6 to 8.5, morphology becoming abnormal in the alkahne media

abnormal in the alkaline media

Most cultures are odorless, although
occasionally a faint reach-like odor can

Growth is not inhibited by the presence of oxygen, although the pigmentation is thereby affected

be detected

Fatty acids and most substituted acids are satisfactory substrates. Rapid and abundant growth with propionate at a concentration of 0 2 per cent. At this same concentration glutaric acid leads, at best, to very meager cultures, while tartrate, citrate and gluconate fail to induce growth, as do also ethanol, glycerol, mannitol and sorbitol. In media with 02 per cent glucose or fructose good growth is obtained. No growth with mannese Thiosulfate is not, but molecular hydrogen can he, oxidized by this species.

Gelatin is not liquefied, of the amino acids alanine and glutamic acid are satisfactory substrates, while leucine is not utilized

Distinguishing proporties: Cell shape and arrangement in chains; brown color of anacrobic, red pigmentation of acrobic cultures, ability to grow in media with 0.2 per cent propionate, glucose, fructose, alanine and glutamic acul; failure to develop with leuene, as well as with ethanol, glycerol, manntol and sorbitol in the above-mentioned concentration.

All cultures can develop anaerobically in illuminated cultures by a photosynthetic metabolism

Temperature optimum distinctly lower than for Rhodopseudomonas palusiris, and, as a rule, around 25°C

Habitat. Regularly found in stagnant bodies of water and in mud.

Hlustrations Molisch, loc. cit., Plato II, fig. 9, van Niel, loc. cit, fig. 4-6, p 19, fig 27-32, p. 92, and fig. 33-33, p 93.

4 Rhodopseudomonas spheroides van Niel (Rhodosecus capsulatus Molisch, Die Purpurhahterien, Jena, 1907, 207, Rhedosecus minor Molisch, ibid, 21; Rhodosphaera enpudafa Ikuchanan, Jour. Bact. 5, 1018, 472; Rhodosphaera minor Bergey et al, Manual, 1st ded, 1923, 495; Rhodorrhayus minor Bergey et al, Manual, 3rd ed, 1930, 535; Rhodorrhayus capsulatus Bergey et al, Manual, 3rd ed, 1930, 535; van Niel, Bact. Rev. 8, 1911, 95.) Trom Latin sphaera, a round body and Greek cidos, form of.

Cells: Cenerally single, nearly sphental, diameter without alime capsule variable, depending upon malium, ranging from 0.7 to 4 microns. In young cultures actively motile by means of polar flagella; motility soon ceases in media which are or become alkalioe. Copious slime production in media at pH above 7. In strongly alkaline cultures abnormal cell-shapes occur in the form of irregular, swollen and distorted rods, often having the appearance of spore bearing cells, simulated by the production of fat bodies. In sugar-containing media egg-shaped cells, measuring as a rule 20 to 2.5 by 2.5 to 35 microns, are frequently found. Gramnegativo.

Color: Anacrobic cultures develop with brown color, ranging to shade from a light, dirty greenish-brown to a dark brawn. Cultures grown in the presence of oxygen are distinctly red. As in the case of Rhodopseudomonas capsulatus, the brown color of an anaerobic culture can be changed to red by shaking with air, light stimulating the color change. Color due to bacteriochlorophyll and carotenoid pigments. The large majority of cultures of this species prinduces in addition a water-soluble, non-carotenoid, bluish-red pigment which diffuses into the culture medium

Celatin is not liquefied, and growth with single amino acids appears somewhat creatic. No definite correlations have been observed.

Development is possible over a wide pH range, extending from at least 60

All cultures exhibit an unpleasant putrid ador.

Requires for optimal development higher coocentrations of yeast extract

Illustrations, Molisch, loc cit, Plate II, 6g. 15; van Niel, loc. cit., fig. 7-8, p 19; fig. 39-45, p. 96, fig 46-54, p 97. Genus II. Rhodosphrillum Molisch emend. van Niel.

as a supply of growth factors than either Rhodopseudomonas palustris or Rhodo. pseulymonas capsulatus and is more sensitive to low fatty acid concentrations. With 0.2 per cent propionate in a neutral medium, no growth occurs, caproic and pelargonic acids are toxic in concentrations below 0.1 per cent. On the other hand, tartrate and gluconate can serve as oxidation substrates, as can also ethagol, glycerol, mannitol, sorbitol, glucose, fructose and mannose ia 0.2 per cent concentrations.

In sugar-containing media, acid is produced; the pH may drop to below 40 before development ceases. Acid production from glucose occurs both in presence and abscoce of air, and ia illuminated as well as in non-illuminated cultures In cultures exposed to light, the acid usually disappears later on.

Thiosulfate is not ovidized, hydrogen oxidation has not been observed.

Ovygen does not prevent growth, colonics develop on the surface of ager plates exposed to air, with a red pigmeetatioe. Capable of strictly anacrobic development in illuminated cultures by photosynthesis.

Temperature optimum below 30°C. Distinguishing properties: Spheneal cell-shape in most media; brown color of anaerobic and red pi-mentation of aerobic cultures; growth with 02 per cent tartrate, gluconate, ethanol, glycerol, mannitol, sorbitol, glucose, fructose and mannose; failure to grow with 0.2 per cent propionate.

Habitat: Regularly found in stagment bodies of water and in mud.

Jena, 1907, 24; vao Niel, Bact. Rev., 8, 1944, 80; the ospirillum Kluyver and van Nicl, Cent. f. Bakt., ck rhodos, red and M.L spirillum, spirillum.

Spiral-shaped bacteria, motile by means of polar flagella Gram-negative.

Contain bacteriochlorophyll and are potentially photosynthetic in the presence of extraneous oudrable substances Molecular oxygen is not produced. Unable to grow in strictly mineral media, even when possessed of the ability to utilize hydrogen as oxidizable substrate, due to the need for organic nutrilites Produce accessory pigments causing the cultures, especially when grown in the light, to appear in various shades of red to brown

The type species is Rhodospirillum rubrum (Esmarch) Molisch

## Key to the species of genus Rhodosphillum.

- 1 Cultures red; cells well over 0 5 micron, usually about 1 to 1 2 microns in width
  1. Rhodospirallum rubrum.
- Il Cultures brown to orange; cells 0 5 micron or less in width.
  - 2. Rhodospirillum fulvum.

l Rhodespitillum rubrum (Lamarch) Molisch (Spirillum rubrum Esmarch, Cent f Bakt, 1, 1837, 223; Molisch, Die Purpurbakterien, Jena, 1997, 23; Rhodespirillum photometricum Molisch, bid, 21, Rhodespirillum giganteum Molisch, bid, 24; Rhodespirillum longum Hisma, Jour Sei Hiroshuma Univ, Ser B, Div 2, 1, 1933, 135; Rhodespirillum graciel Hama, bid, 159) From Latin ruber, red.

Characteristically shaped, but size of elements variable within wide limits, depending upon environmental conditions during growth Width of cells from 0.5 to 1.5 microns. length from 2 to 50 microns, and over, even in a single culture such differences may be found. Also the shape and size of the spiral coil varies much, it usually ranges between 1 to 4 microns in width, and from 1.5 to 7 microns in length alanine media the majority of the cells occurs in the form of half-circles to complete rings, malate media tend to produce much flattened spirals In old cultures involution forms ap-

In oid cultures involution forms appear, straightened spirals and irregularly swollen cells, the latter common in media with higher fatty acids Such cells stain irregularly, contain fatty inclusions, and are occasionally branched

Mucus is not produced. In calciumdeficient media the growth is flocculent, as if agglutinated. With an adequate calcium supply the growth in figuid media is homogeneous, suspended, and consists of single cells

Young cultures show active motility, due to polar flagella. Gram-negative Gelatin is not liquefied; the amono acids alanine, asparagine, aspartic and glutamic acids are satisfactory oxidiz-

able compounds

Color Ordinarly deep and dark rel, without any brownish tings. In othanol media lighter, and a characteristic pink. Pigment production markedly influenced by oxygen and light. Slants insubated in darkness present a pale grayesh surface growth with a faint reddish line, while often showing deep-red cell masses in the region between glass wall and agar surface where development proceeds at low oxygen tension. The color is due to bacterochlorophyll and cardenoid pigments. Among the latter spirilloxan thin is a quantitatively predominant.

not produced.

Development possible over a pH range of at least 6 to 8.5, although, as in other cases, the combination of an acid reaction and the presence of fatty acids may prevent growth.

Water-soluble, diffusible pigments are

Cultures produce a distinctive odor, reminiscent of slightly putrid yeast

In general, grow well with fatty acids as the chief ovulizable substrate; however, are prevented from growing by 0.2 per cent propionate in a neutral medium. Most substituted acids are cambly satisfactory, with the exception

of tartrate, gluconate and citrate. In a concentration of 0.2 per cent, ethanol is a suitable substrate, whereas the carbohydrates and their corresponding polyalcohols are not utilized.

Thiosulfate is not oxidized; molecular hydrogen can be used by some strains.

Rather microaerophilic; many strains upon initial isolation incapable of growth at atmospheric oxygen tension. Subsequent adaptation can he induced. But even such adapted cultures exhibit negative chemotaxis to air.

Capable of strictly anaerobic development in illuminated cultures on the basis of a photosynthetic metabolism.

Temperature optimum generally between 30° and 37°C.

Distinguishing properties: The most important characteristics of the species are the spiral shape, combined with the ability to produce a red pigment with a definite absorption maximum at 550 millimierons in the intact tells. Diagnostically useful are the good growth in media with 0.2 per cent ethanol, alaning, asparatel or glutamate, and the inadequacy of similar concentrations of carbohydrates and thiosulfate as substrates.

Habitat: Regularly present in stagment bodies of water and in mud.

Illustrations. Molisch, loc. cit., Plate I, fig. 5-7; van Niel, Baet Rev., 8, 1944, fig. 9-10, p 19; fig 11-16, p. 24; fig. 67-75, p. 103; fig. 76-84, p. 104; fig 85-90, p. 106; fig. 91-96, p. 107

 Rhodospirillum fulvum van Niel. (Bact. Rev., 8, 1914, 108.) From Latin fulvum, yellowish, tawny.

Characteristic for the species as the very small size of the individual cells. These are not over 0.5 micron wide, and generally not longer than 2.5 microns. The most common shape consists of a complete turn of about 1 by 1.5 microns. In media with fatty acids as a substrate the spirals appear somewhat steeper than in fumarate, succinate or malate cultures. Swollen individuals resembling

vibrios are encountered in cultures which do not appear quite healthy. Formation of mucus or clumping has not been observed.

Gelatin is not liquefied; aspartate has been the only amino acid capable of inducing growth Thiosulfate is not ovidized.

Color: Quite distinct from that of Rhodsspirillum rubrum; colonies and stab cultures are a reddish-brown, while liquid cultures often appear brownish-orange. The color is due to bacterio-chlorophyll and cartenoid pigments; among the latter spirillovanthin, as evidenced by the absence of an absorption maximum at 550 millimerons, is not represented as a major constituent. Does not produce water-soluble, diffusible birments

Capable of strictly annerobic development in illuminated cultures, due to photosynthetic metabolism.

Fatty acids and the four-carbon disaboxylic acids are uniformly good substrates; glutarate is not used. Ethanol and glucose, in a concentration of 0.2 per cent, bave yielded satisfactory cultures; other carbohydrates, as well as the corresponding polyaleohols, have given negative results.

Little information available concerning pH and temperature relations. Behaves generally as a strict anaerobe; adaptation to microacrophilic conditions has not been achieved. Negative aerotanis very ronounced.

Distinguishing properties: The small size and the color of the cultures serve as adequate criteria for its differentiation from Rhodospirillum rubrum. The strictly anaerobic nature and the failure to grow with glutarate and various amino acids evcept aspartate can probably be used as supplementary specific properties.

Habitat: Bodies of stagnant water and

Illustrations: Van Niel, loc cel , fig-97-102, p. 109

#### FAMILY III. CHLOROBACTERIACEAE GEITLER AND PASCHER.

(Cyanochloridinae-Chlorobacteriaceae Geitler and Pascher, Die Süsswasserflora Deutschlands, Österreichs und der Schweiz, Jena, 12, 1925, 451; Chlorothiobacteria Bavendamm, Ergeb. Biol., 13, 1936, 49)

Green bacteria, usually of small size, occurring singly or in cell masses of various shapes and sizes, developing in coveronments containing rather high concentrations of hydrogen sulfide and exposed to light As a rule not containing sulfur globules but frequently depositing clementary sulfur outside the cells. Contain green pigments of a chlorophyllous nature, though not identical with the common green plant chlorophylls nor with bacteriochlorophyll. Capable of photosynthesis in the presence of hydrogen sulfide; do not liberate oxygen.

A number of genera have been proposed, characterized by special colonial growth forms, others on the basis of a supposed symbiotic habitus, where the green hacteria grow in more or less characteristic aggregates together with other micro-organisms. In view of the variations in size and shape exhibited by the only member of this group which has so far been obtained and atudied in pure culture (van Nicl, Arch. f. Mikrobiol , 3, 1931, 65ff ) the validity of many of these genera is doubtful. The fellowing keys and descriptions, therefore, bear a strictly provisional character. Here, as in the case of the sulfur purple bacteria, significant advances can only be expected from pure culture studies under controlled environmental conditions

#### Key to the genera of family Chiorobacterlaceae.

- 1 Free-living bacteria not intimately associated with other microbes. a. Bacteria not united into well defined colonies.
  - Genus I. Chlorobium, p. 869.
  - aa Bacteria united into characteristic aggregates.
    - b. Bacteria without intracellular sulfur globules. Genus II. Pelodictyon, p. 870
    - bb. Bacteria with intraccilular sulfur globules.
- Genus III. Clathrochloris, p. 872. If. Green bacteria found as symbiotic aggregates with other organisms.
  - a. Aggregates composed of green bacteria and protozoa.
  - Genus IV. Chlorobacterium, p. 872.
  - aa. Aggregates composed of two different types of bacteria.
    - - h. Aggregates small, barrel-shaped, actively motile, and consisting of a central, polarly flagellated, rod-shaped bacterium with a covering of green sulfur hacteria.

Genus V. Chlorochromatium, p. 873.

hb Aggregates large, eylindrical, non-motile, and composed of a central filamentous hacterium with a more or less extensive covering of green sulfur bacteria.

Genns VI. Culindrogloca, p. 873

### Genus I. Chlorobium Nadson.

(Nadson, Bull. Jard. Imp(r. Botan., St. Pétersb., 12, 1912, 64 (Russian), 83 (German), Chloronostoc Pascher, Die Susswasserflora Deutschlands, Österreichs und der Schweiz, Jena, 12, 1925, 456, Tetrachloris Pascher, abid., 455; Sorochloris? Pascher.

<sup>\*</sup> Completely revised by Prof. C B van Niel, Hopkins Marine Station, Pacific Grove, California, January, 1944.

ibid., 455; Phinanes. 3-123; in part '

' crobiol., 8, 1937, Vereins, Heidel.

berg, N.F. www, green and bros, life.

Green sulfur bacteria, occurring singly or in chains, individual cells of various sizes and shapes, from spherical to relatively long rod-shaped, the latter cometimes coiled into tight enterior - fe

capsule. N mon green t

thesis in the presence of hydrogen sulfide, during which they produce elementary sulfur which is excreted outside the cells. Do not form spores

The type species is Chlorobium limicola Nadson,

I. Chloroblum Nadson. limicola (Nadson, Bull. Jard. Impér. Botan., St. Pétersb., 12, 1912, 61 (Russian), 83 (German); Chloronostoc abbreviatum Pascher, Süsswasserflora Deutschlands. Osterreichs und der Schweiz, Jena. 12, 1925, 456; Tetrachloris inconstans Pascher, ibid., 456; Sorochloria oggregata? Pascher, ibid., 455; in part Pelogloca chloring Lauterborn, Verhandl. naturhistor .- medizm. Vereins. Heidelberg, N.F. 15, 1915, 430.) From Latin. mud-dweller.

Cells: Various shapes and sizes, markedly dependent upon environmental conditions. In young and healthy state predominantly spherical to ovoid, about 0 5 to 1 micron in diameter, frequently united in chains resembling streptococci. Often cells become elongated and appear as rods, generally about 0.7 micron by 1 to 2.5 microns; also these may remain united in chains. Regularly produce mucus, causing the formation of cellconglomerates of different size and shape, but not, as a rule, of characteristic appearance.

Color yellowish green. Non-motile Abnormal cell forms (involution forms) rather common. These may be larger spherical cells, up to 5 to 6 microns in diameter, the larger ones generally vacuolated, or long rods, occasionally club-shaped but more often coiled In rare cases the latter may be loosely wound. More frequently they are tightly-coiled screws, with cells of about 0 5 micron in diameter by as much as 15 mucrons in length. The spherical involution forms are normally encountered in acid, the coiled ones in alkaine ea-

vironments. Strictly anaerobic and apparently dependent upon hydrogen sulfide and light. Development in organic media has not been obtained.

Habitat: Mud and stagnant water containing rather high concentrations of hydrogen sulfide and exposed to light, more rarely in sulfur springs

Illustrations: Nadson, loc. cit , Pl. III, fig. 3-12, van Niel, Arch. f. Mikrobiol.,

3, 1931, 66, fig. 8.

# Genus II. Pelodictyon Laulerborn.

(Lauterborn, Aligem. botan. Ztschr., 19, 1913, 93; Verhandl. naturbistor. medizin. Vereins, Heidelberg, N.F. 15, 1915, 431; Schmidlea loc. ett., Lauterborn, Allgem botan, Zeitschr., 19, 1913, 37; in part, Pelogloca Lauterborn, Verhandl. naturbist. medizin Vereins, Heidelberg, N.P. 13, 1915, 430; Pediochloris Geitler, Die Susswasserflora Deutschlands, Österreichs und der Schweiz, Jena, 12, 1925, 457.) From Greek pelos, mud and dictyon, net.

Green sulfur bacteria, individual cells ovoid to distinctly rod-shaped, producing rather extensive mucoid capsules, and generally united into large colonies of characteristic shapes. Non-motile. Contain chlorophyllous pigments different from the common green plant chlorophylls and from bacteriochlorophyll. Capable of photosynthesis in the presence of hydrogen sulfide, but do not store sulfur globules inside the cells.

The type species is Pelodictyon clathratiforme (Szafer) Lauterborn.

#### Key to the species of genus Pelodictyon.

- I Cells united in colonies in a net-like fashion.
  - Pelodictyon clathratiforme.
- 11. Cells arranged in tightly packed colonies without net-like structure.
  - Colonies composed of irregularly arranged cell-masses, extending in three dimensions.
    - 2 Pelodictyon aggregatum
  - na Colonics consisting of parallel strands and extending in two dimensions.

    3 Pelodictyon parallelum

1 Pelodictyon elatinatiorime (Szaler) Lauterborn (Aphanothece elatinotiforme Szafer, Bull Acad Sci., Cracovic, Sef. R., 5, 1901, 162, Lauterborn, Allgem botan Ztschr., 19, 1913, 93, Lauterborn, Verlandl naturhist medizin Vereins, Heudelberg, NR. 18, 1915, 439, Pelodicipon clativatiforme Gettler, Die Süsswasserflora Deutschlands, Österreichs und der Schweiz, Jena, 12, 1925, 438; Pelodicipon Lauterborni Gettler, bird., 488) From Greek elathros, trellis and formis, shape.

Cells Generally rod-shaped, ranging from slightly elongated ovidis to distinct rods, often vaccolated, about 0.5 to 1.5 micron by 2 to 4 microns, producing rather wide slime capsules, and characteristically united into three-dimensional colonies which present a net like appearance, with marcs of about 10 to 50 microns

Color yellowsh-green. Non-mottle Abnormal cell forms (involution forms) not uncounten, consisting of clongated and curred, lorded, or clob-shaped and swollen rods, occasionally suggesting rudimentary branching at the extremities. Such cells may be found as elements in chains for the greater part composed of normal individuals.

Habitat. Mud and stagnant water containing rather high concentrations of hydrogen sulfide and exposed to light; sulfur springs

Illustrations. Szafer, loc. cit, Pl. VI,

fig 5; Perfiliev, Jour. Microbiol., (Russian), 1, 1914, Pl. II, fig 1, 5-12; Lauterborn, loc cit, 1915, Pl. III, fig. 33.

2 Pelodictyon aggregatum Perfilev. (Aphanothece luteda Schmidle, Behelte Botan Cent., 10, 1901, 179; Schmidlez Leuteola Lauterborn, Milgem. botan. Ztechr, 19, 1913, 97; Lauterborn, Verhandl naturhator-medism. Vereins, Heidelberg, Nr., 13, 1915, 429, Pelo-gloca bacillifera Lauterborn, tbid., 430; Perfilev. Jour. Mierobol (Russan), 1, 1914, 197) From Latin aggregatus, leading together, grouping

Cells Usually rod-shaped, about 1 to 15 microns by 2 to 4 microns, often vacuolated, producing micros capsules, and unted into irregularly shaped, three-dimensional colonies in which the cells are more or less tightly packed, without orderly arrangement. Colonies may attain a size of up to 1 mm; frequently they are not fully compact, but combain less dense areas, or appear perforated, thus forming transition stages to Pelodictions calabratifyems.

Color yellowish-green. Non-motile. Abnormal cell forms (involution forms) usually in the shape of elongated and curved, forked or club-shaped and swollen rods, occasionally suggesting branching at extremities.

Habitat Mud and stagmant water, containing rather high concentrations of hydrogen sulfide, and exposed to light: sulfur springs.

Illustrations: Perfiliev, loc. cit . Pl. II. fig. 2: Lauterborn, loc. cit., Pl. III, fig.

3. Pelodictyon parallelum Perfiliev. (Aphanothece parallels Szafer, Bull. Acad. Sci., Cracovie, Sér. B, 3, 1910, 163; Perfiliev, Jour. Microbiol. (Russian), 1, 1914, 198; Pediochloris parallela Geitler, Die Süsswasserflora Deutschlands, Österreichs und der Schweiz. Jena. 12, 1925. 457.) From Latin parallelus, beside one another.

Cells: Rather small, spherical to ovoid. or even rod-shaped; about 0.5 to 1 micron by 1 to 3 microns, occurring in chains. and forming flat, plate-like, two-dimensional aggregates in which the chains are arranged as parallel strands.

Color yellowish-green. Non-motile. Abnormal cell forms not specifically

mentioned, but likely to occur, and to resemble those of other species.

This species may well be a special growth-form of Chlorobium limicola.

Habitat: Mud and stagnant water containing rather high concentrations of hydrogen sulfide and exposed to light; sulfur springs.

Illustrations: Szafer, loc. cit., Pl. VI, fig. 7; Perfiliev, loc. cit., Pl. II, fig. 2

# Genus III. Clathrochloris Geitler.

(Die Süsswasserflora Deutschlands, Österreichs und der Schweiz, Jena, 12, 1925, 457.) From Greek clathros, trellis and chloros, green.

Green sulfur bacteria of small size, generally spherical, and arranged in chairs which are united into loose, trellis shaped aggregates, somewhat similar to those of Pelodictyon clathratiforme and Pelodictyon aggregatum. Cells usually contain sulfur globules. Color yellowish green. Non-motile.

The type species is Clathrochloris sulphurica (Szafer) Geitler.

1. Clathrochioris sulphurica (Szafer) Geitler. (Aphanothece sulphurica Szafer, Bull, Acad Sci , Cracovie, Sér. B, 3, 1910, 162; Geitler, Die Süsswasserslora Deutschlands, Österreichs und der Schweiz, Jena, 12, 1925, 457) From Latin, containing sulfur.

Cells. Spherical, about 0 5 to 0.7 micron in diameter, usually containing sulfur globules. Color yellowish-green. Non-motile.

The reported occurrence of sulfur globules in the cells of this very small species is surprising, it is the only one nmong the green sulfur bacteria in which these inclusions bave been encountered The published descriptions are even more fragmentary than those of other members of the group

Source: Reported only from sulfur springs in Lubién Wielki, near Lnow,

Poland.

Habitat: Mud and stagnant water containing rather high concentrations of hydrogen sulfide and exposed to light; sulfur springs.

Illustration: Szafer, loc cit., Pl. VI, fig. G.

# Genus IV. Chlorobacterium Laulerborn.

Verbandt neturhist medizin. Vereins, Heidelberg, N.F., 12, 1915. . Schneiz, Il rod. on cells curved.

of protozoa, such as amocha ann nagenates. : The type species is Chlorobucterium symbioticum Lauterborn. greenish. Non-motile.

1 Chlorobacterium symbloticum Lauterborn. (Lauterborn, Verhandl. naturhist.medizin Vereins, Heidelberg, N F. 13, 1915, 429; Chroostipes Innears Pascher, Die Stisswasserfora Deutschlands, Österreichs und der Schweis, Jens, 12, 1925, 116.) From Greek, Irving symblotically

Cells Rod-shaped, about 0.5 by 2 to 5 microns, often slightly curved Nonmotile

Occur as a peripheral covering of certain protozoa with which they may form a symbiotic unit. It is not certain that this is a green sulfur bacterium; the description of localities where it was found fail to mention the presence of hydrogen sulfide in the environment which should be a prerequisite for a member of this group

Source Reported from a number of pools in Germany.

Habitat Stagnant water

Hillustrations: Lauterborn, loc cit., Pl III, fig 34-36; Pascher, loc. cit., fig 149

#### Genus V. Chlorochromatium Lauterborn

(Lauterborn, Allgem. botan Ztschr, 19, 1906, 1905; Chloronium Buder, Ber. d. deut. bot Ges., 31, 1914, Generalversammlungsheft, 80) From Greek chloros, green and chroma, color.

Green sulfur bacteria, evoid to rod-shaped with rounded ends, occurring as barrelshaped sggregates, consisting of a rather large colorless bacterium with a polar flagellum as the center, surrounded by the green bacteria, arranged in 4 to 6 rows, ordnarily from 2 to 4 cells high The entire conglomerate behaves like a unit, is motile, and multiplies by the more or less simultaneous fission of its components.

The green constituents contain a chlorophyllous pigment which is not identical with the common green plant chlorophylls or with bacteriochlorophyll. Capable of photosynthess in the presence of hydrogen sulfide, but do not store sulfur globules in the cells

The type species is Chlorochromatium aggregatum Lauterborn.

1 Chlorochromatium aggregatum Lauterborn (Lauterborn, Allgem botan Zischr, 19, 1900, 190, Chloronium mirabile Buder, Ber deut botan Ges, 31, 1914, Generalversammlungsheft, 80 ) From Latin aggregatus, grouped

Cells of the green component 0.5 to 10 by 10 to 2.5 nucrons, mostly from S to 16 individuals surrounding the central bacterium. Size of the total barrelshaped unit variable, generally 2.5 to 5 by 7 to 12 nucrons. Occasionally a group of the complex colonies may remain at tached in a chain.

Anaerobic

Habitat Mud and stagnaut water con

taining rather high concentrations of hydrogen sulfide and exposed to light.

There is at present no good reason for distinguishing 2 varieties (forms typica and forma minor) or even species, on the basis of size differences of the colony, as Gettler proposed (Die Süssnasserflora Deutschlands, Ozterreichs und der Schweiz, Jena, 13, 1925, 400). The reported and personally observed sixes of such units show that the extreme limits are linked by a complete series of transi-

Hillustrations Buder, loc. cit., Pl. XXIV, fig 1-5, Perfiliev, Jour. Microbiol (Russian), I, 1914, 213, fig 1-5

#### Genus VI. Cylindrogioca Perfilier

(Jour. Microbiol (Russian), 1, 1914, 223) From Latin cylindrus, cylinder and Greek gloios, a glutinous substance.

Green sulfur bacteria, consisting of small ovoid to rod-shaped cells, growing in association with a filamentous, colorless, central bacterium, thus forming colonies of a cylindrical shape. Non-motile. The green component contains a chlorophyllous pigment different from the common chlorophylls of green plants and from beteriochlorophyll. Capable of photosynthesis in the presence of hydrogen sulfide, without depositing sulfur globules in the cells.

The type species is Cylindrogloca bacterifera Perfiliev.

 Cylindrogloca bacterifeta Perfiliev. (Jour. Microbiol. (Russian), 1, 1914, 223.)
 From Latin bacter, rad and fero, to bear.

Individual green components ovoid to rod-shaped, about 0.5 to 1 by 2 to 4 mierons, very similar to those of the complex Chlorobucterium symbioticum and Chlorochromatium agoregatum with which they may well be identical. The central filamentous bacterium is embedded in a slime cansule of considerable dimensions. This, in turn, is surrounded by a layer of green bacteria, usually one cell thick. The green organisms may form a very dense outer covering, or they may be more sparsely distributed over the mucus capsule The entire unit is again surrounded by a sizeable slime zone. Aggregates measure about 7 to 8 microns in width, and up to 50 microns in length; they are non-motile. Both components annear to be non-spore-forming.

Habitat: Mud and stagnant water containing rather high concentrations of hydrogen sulfide and exposed to light. Illustration: Perfiliev, Inc. cit., 213, for 6-11.

Perfiliev rightly emphasizes, as Buder had dong for Chloronium mirabile, the provisional nature of thus using a generic designation for an apparently stable complex composed of two different organisms. It remains possible that the last three genera of symbiotic entities represent fortuitous combinations whose occurrence is conditioned by environmental factors If so, the generic terminology would be devoid of any tarenomic significance, and the green bacteria should be relegated to more appropriate genera. Indications suggestive of this state of affairs can be found in the literature; for example in Utermohl's observation (Archiv f. Hydrobiol, Suppl. 5, 1925, 279) that the complex Chlorochromatium aggregatum may, especially in the presence of ovygen, disintegrate, whereupon the green constituents appear as small Pelodiciyon aggregatum (Schmidlea luteola) colonies.

#### ORDER II. ACTINOMYCETALES BUCHANAN.

(Jour. Bact., 2, 1917, 162)

Organisms forming elongated cells which have a definite tendency to branch. These byphae do not exceed 1 5 microns and are mostly about 1 micron or less in diameter. In the Mucobacterraceae the mycelium is rudimentary or absent; no spores are formed: the cells are acid-fast. The Actinomycetaceae and Streptomycetaceae usually produce a characteristic branching mycelium and multiply by means of special spores, oidiospores or conidia Special spores are formed by fragmentation of the plasma within straight or spiral-shaped spore-bearing hyphae; the oidiospores are formed by segmentation, or by transverse division of hyphae, similar to the formation of oidia among the true fungi, the conidia are produced singly, at the end of simple or branching conidiophores They grow readily on artificial media and form well-developed colonies The surface of the colony, especially in the Actinomycetaceae and Streptomycetaccae, may become covered with an aerial mycelium. Some form colorless or white colonies, whereas others form a variety of pigments Some species are partially acid-fast. In relation to temperature, most are mesophilic, while some are thermophilic Certain forms are capable of growing at low oxygen tension. The Order as a whole is composed of saprophytic species, but also includes species that are parasitic and sometimes pathogenic on both animals and plants

Kay to the families of order Acthomycetales.

I Mycelium rudimentary or absent, no spores formed. Acid-fast.

### Family I Mycobacteriaceae, p 875.

II Truo mycelium produced

A. Vegetative mycelium divides by segmentation into bacillary or eoceoid elements. Some species partially acid-fast

Family II. Actinomycetaceae, p 892.

B Vegetative myeelium normally remains undivided.

Family III. Streptomycetaceae, p. 929.

Among the recent systems of classification of this order it is sufficient to mention the following Baldace (B)ycopath 2, 1933, \$4) divided the order Actinomyctales into two families (a) Mycobacteriaecae Chester with two subfamilies, Leptatrichiordeae Baldacel and Proactinomycoudeae Baldacel, each with five genera, and (b) Actinomycetaecae Buchanan, with two genera, Micromonospora and Actinomyces, Krassilinkov (Ray fungi and related organisms, 1rd Akad. Nauk, Moskow, 1938) divided the order into (a) Actinomycetaecae, with four genera, Actinomyces, Proactinomyces, Mycobacteriae and Mycooccus, and (b) Micromonosporaecae, with one genus, Micromonosporae (Maximan (Jour. Bact., 29, 1940, 549) divided the order into four families: Mycobacteriaecae, Proactinomycetaecae, Actinomycetaecae and Micromonosporae.

## FAMILY I. MYCOBACTERIACEAE CHESTER \*

(Chester, Man. Determ Bact., 1901, 349; Proactinomycetaceae Lehmann and Haag, in Lehmann and Neumann, Bakt. Diag., 7 Aufl., 2, 1927, 674)

Completely revised by Prof G B Beed, Queens University, Kingston, Ontario, Canada, December, 1938, minor revisions, December, 1911, with a complete revision of Mycobocterium teprae and M. tepracmurium by Dr John H. Hanks, Leonard Wood Memorial, American Leprosy Foundation, New York, N. Y.

Glycerol broth: After 8 weeks, thick, white or cream-colored, wrinkled pellicle extending up the sides of the flask, no turbidity; granular or scaly deposit.

Dorset's egg slants: After 4 weeks, rather sparse, discrete or confluent, slightly raised, grayish-yellow growth with finely granular surface.

Glycerol egg slants: After 4 weeks, luxuriant, raised, confluent, gray to yellow growth, with granular surface, generally with nodular heaped-up areas.

Congulated beel scrum: After 4 weeks, thin, effuse, confluent, gray to yellow growth, with a very fine granular surface.

Glycerol beef serum: After 4 weeks, luxuriant, thick, raised, confluent, yellow to orange-yellow growth, with coarsely granular surface, generally with irregularly heaped-up areas.

Litmus milk Growth, but no change in the milk

Glycerol potato: After 4 weeks, luxuriant, raised, confluent, cream-colored

ab-

and lactose not utilized (Merrill, Jour. Bact., 20, 1930, 235, based on the examination of one strain).

Optimum temperature 37°C

Optimum pH 7.4 to 8.0 (Islumori, Ztschr f. Hyg, 102, 1924, 329); pH 6.0 to 8.5 (Dernby and Naslund, Biochem. Zeit, 132, 1922, 392).

Pathogenicity. Produces tuberculosis in man, monkey, dog and parrot. Experimentally, it is highly pathogenic for guinea pigs but not for rabbits, cats, goats, oven or domestic fowls.

Intermediate mammalian types: Griffith (Lancet, 1, 1916-17, 721; Jour. Path and Bact., 21, 1924, 54) has found aberrant types particularly in skin fesions of both man and ox, which are in certain characteristics intermediate between the human and the bovine varieties. He finds no evidence, however, that the one variety may change into the other.

Variation · Variation in colony structure of the two mammalian varieties,

comparable with that in other species, has been described by several authors, as Petroff et al. (Jour. Exp. Med , 60, 1934, 515), Birkhaug (Ann. Inst. Past, 57, 1933, 428), Kahn et al. (Jour. Baet, 25, 1933, 157), Uhlenhuth and Sieffert (Zeit Immun , 59, 1930, 187), Reed and Rice (Canad. Jour. Res., 5, 1931, 111), Smithburn (Jour. Exp. Med., 63, 1936, 95) and Shaffer (Jour. Path. and Bact., 40, 1935, 107). Several of these authors have found associated variation in cell structure and in virulence though Boquet (Compt. rend. Soc. Biol. Paris, 103, 1930, 290). Birkhaug (Ann. Inst. Past., 49, 1932, 630), and others, have failed to find differences in virulence. Reed and Rice (Jour. Immunol., 23, 1932, 355) found the S form to contain an antigenic substance lacking in the R form.

Antigenic structure: By agglutination, absorption of agglutinins and complement fixation a distinction may be made between the mammalian varieties and Mucobacterium avium, but it has been impossible to distinguish, by these means, between the two manimalian varieties (Tullock et al., Tubercle, 6, Oct.-Dec, 1924, 18, 57 and 105; Wilson, Jour. Path. and Bact., 28, 1925, 69; Griffith, Tubercle, 6, May, 1925, 417; Rice and Reed, Jour. Immunol., 23, 1932, 385; Kauffman, Ztschr. f. Hyg., 114, 1932, 121). Tuberculins prepared from the human and the bovine varieties are ordinarily in-· · - · - hat Temis

1931,

aphylactic reactions.

aphysical reactions. Tubercle bacilli pathogenie for guinea pigs and rabhats, not for fowls. Mycobacterium tuberculosis var. hominis produces generalized tuberculosis in guinea pigs but not in rabbits. Mycobacterium tuberculosis var. boris produces generalized dasease in both guinea pigs and rabbits. Growth of the human variety is enhanced by the addition of glycerol to met media. The growth of the bowne variety is not enhanced by the addition of glycerol. The human variety generally develops yellow to red pigment on serum media, while the bovine variety never produces pigment Antigenically

the two varieties are not distinguishable. Source From tuberculous lesions in man

The cause of tuberculosis Habitat in man. Transmissible to rabbits and guinea piga.

1b. Mucobacterium tuberculosis var bovis Lebmann and Neumann. (Bovine tubercle bacilli, Th Smith, Trans. Assoc. Am Phys., 11, 1896, 75; 13, 1898, 417, Jour Exp Med , 3, 1898, 451, Mucobacterium tuberculosis typus botinus Lohmann and Neumann, Bakt Ding , 4 Aufl , 2, 1907, 550 ) From Latin borss, of the ox

Common name Bovine tubercle bacillus

Description from Th Smith (loc cit ) and Topley and Wilson (Princip of Bact and Immun , 2nd ed , 1936, 315)

Rods which are shorter and plumper than the human type Range in size from 10 to 1.5 microns Very short forms are frequently intermixed with somewhat larger forms Stain regularly or irregularly. Acid-fast and acid-alcohol-fast. Gram-positive Less easily cultivated than the human variety

Nutrient agar · No growth

Glycerol agar colonies Small, pregular, with granular surface, no pigment,

Glycerol agar slant: After 4 weeks, thin, granular or effuse, confluent growth. Nutrient broth: No growth

Glycerol broth, After S weeks, thin grayish-white film, slightly nodular, no turbidity. Slight granular deposit

Dorset's egg slants; After 4 weeks, similar to var. hominis but generally poorer growth and no pigmentation

Giveerol egg slants. After 4 weeks. similar to Dorset's egg slants.

Congulated beef serum. After 4 weeks, thin, effuse, confluent, white to gray growth with very fine granular aurface, Generally less luxuriant than in the human variety

Glycerol heef scrum. After 4 weeks, similar to plain beef serum.

Glycerol potato: After 4 weeks, thin, effuse, grayish growth Litmus milk Growth, but no change in

the milk.

Optimum temperature 37°C.

Optimum pH 58 to 69 (Ishimori. Ztschr f. Hyg , 102, 1924, 329); 6 0 to 6 5 (Dernby and Naslund, Biochero, Zeit., 152, 1922, 392).

Pathogenicity: Produces tuberculosis in ox, man, roonkey, goat, sheep, pig. cat, parrot, cockatoo and possibly some birds of prey. Experimentally, it is highly pathogenic for rabbit and guinea pig, slightly pathogenic for dog, horse,

rat and mouse, not pathogenic for fowls. Variation See Mycobactersum tuberculosis var. hominis.

Antigenic structure. See Mycobacterium tuberculosis var. hominis

Distinctive characters See Mycobac.

terium tuberculosis var hominis Source From tubercles in cattle

Habitat The cause of tuberculosis in cattle Transmissible to man and domestic animals More highly pathogenic for animals than the human type.

2 Mycobacterium aylum Chester. (Tuberculose des oiscaux, Strauss and Gamaléia, Arch. Méd exp et Anat. path , 1891; Bacillus der Huhnertuberculose, Maffucci, Ztschr f Hygiene, 11. 1892, 449; Bacillus tuberculosis gal-Ingrum Sternberg, Man of Bact , 1893. 392, Mycobacterium tuberculosis arium Lehmann and Neumann, Bakt Diag , 1 Aufi , 1, 1896, 370, Bacillus tuberculosis arrum Kruse, in Flügge, Die Mikroorganismen. 3 Aufl. 2, 1596, 506; Mucobacterium arium Chester, Manual Determ Bact , 1901, 357, Mycobacterium tuberculosis typus gallinaceus Lehmann and Neumann, Bakt Diag , 4 Aufl., 2. 1907, 553) From Latin aris, bird.

Common name: Avian tubercle hacillus.

Description from Strauss and Gamaléis (loc. cit.) and Topley and Wilson (Princip. of Bact. and Immun., 2nd ed., 1936, 315).

Rods resembling these of the bovine type of tuhercle organism.

Nutrient agar: After 4 weeks, slight growth, effuse, translucent with fine granular surface.

Glycerol agar colonies: After 3 to 4 weeks, raised, regular, hemispherical, creamy or white colonies.

Nutrient broth: Alter 4 weeks, very slight viscous to granular bottom growth, no pellicle, no turbidity.

Glycerol broth: After 4 weeks, diffuse, turbid growth with a viscous to granular deposit.

Dorset's egg slants: After 4 weeks, confluent, slightly raised growth, with smooth regular surface.

Glycerol egg slants: After 4 weeks, luvuriant, raised, confluent, creamy to yellow growth with perfectly smooth surface.

Congulated beef serum: After 4 weeks, thin, effuse, grayish-yellow growth with smooth surface.

Glycerol beef scrum: After 4 weeks, lururiant, raised, confluent, yellow to orange-yellow or occasionally pale pink growth, with a smooth glustening surface.

Glycerol potato: After 4 weeks, luxuriant, raised, confluent, with smooth to nodular surface.

Litmus milk: Growth, but no change in the milk.

Carbohydrates: Fructose, arabinose and sucrose are utilized, glucose is slightly utilized, galactose and lactose are not utilized (Merrill, Jour. Bact., 20, 1930, 235, based on the examination of one strain).

Optimum temperature 40°C; range 30°

to 44°C (Bynoe, Thesis, McGill University, Montreal, 1931).
Outlinum pH 6.8 to 7.3 (Bynoe, loc.

Optimum pH 6.8 to 7.3 (Bynoc, loc.

Pathogenicity: Produces tuberculosis in domestic fowls and other birds. In pigs it produces localized and sometimes disconinated discase. Experimentally in the rabbit, guinca pig, rat and mouse it may proliferate without producing macroscopic tubercles—tuberculosis of the Yersin type. Man, ox, gax, cat, horse, dog and monkey are not infected.

Variation: Winn and Petroff (Jour. Exp. Med., 57, 1933, 239), Kahn and Schusrtzkopf (Jour. Bact., 25, 1933, 157), Birkhaug (Ann. Inst. Pasteur, 64, 1935, 19), Reed and Rice (Canad. Jour. Res., 5, 1931, 111) and others, have shown variation to follow the course described for many species. Winn and Petroff have separated four colonial types; smooth, flat smooth, rough, deep yellow smooth. These also differ in chemical and physical properties. The smooth form exhibited the greatest degree of virulence, the flat smooth a lower virulenco, while the chromogenic smooth and the rough were relatively henign. Some suthors have failed to demonstrate this difference in virulence. The sbove description applies primarily to the smooth

form.

Antigenie structure: By agglutinstion, absorption of agglutinins and complement fixation Algobacterium arium may be distinguished from other members of the genus (Tullock et al., Tubercle, 8, 1924, 18, 57 and 105; Wilson, Jour. Path. and Bact., 28, 1925, 69; Mudd, Proc. 50c. Exp. Biol. and Med., 25, 1922, 599, and others). Furth (Jour. Immunol, 12, 1926, 273) and Bact., 40, 1925, 107) on this basis divided Mycobacterium avium into 1 or 2 subgroups.

Distinctive characters: Tuberele lacilli pathogenie for fouls, not for suices pigs or rubbits. Culturally distinguished from the mammalian types by the absence of pulitic formation in fluid media and the habit of growth on mest colid media. Antigenically distinguished from other species.

Source: From tubercles in fowls, widely distributed as the causal agent of tuberculosis in birds and less frequently in

pigs.

Habitat The cause of tuberculesis in chickens. Transmissible to pigeon, other birds, mouse, rabbit and pig

3 Mycobseterium paratuberculosis Bergey et al. (Darmtuberculoss bacillen, Johne and Frothingham, Deutsch Ztschr. Tiermed, 21, 1895, 438; Pseudotuberkulose bacillen, Bang, Berl. terärzit. Wehnschr, 1896, 759, Bacillus of Johne's Disease, M'Fadyean, Jour Comp Path, 20, 1907, 48, Twort, Proc Roy Sec. J. 83, 1910, 156; Bergey et al., Manual, 1st ed., 1923, 374) From M. L. paratuberculosis, of the disease paratuberculosis.

Common name. Johne's bacillus

The organism from a similar disease in sheep is probably identical though more difficult to cultivate (Dunkin and Balfour-Jones, Jour Comp Path, 48, 1935, 235)

Description from M'Fadycan (loc cit) and Twort and Ingram (A Monograph on Johne's Discase, London, 1913)

Plump rods, 1 0 to 2 0 microns in length, staining uniformly, but occasionally the longer forms show alternately stained and instained segments Non-motile Acid-fast

The organism is difficult to eultivate and, in primary cultures, las only been grown in media containing dead tubercle bacilli or other dead neid-fast bacteria (Boquet, Ann Inst Pasteur, 57, 1928, 493) In a few instances cultures have been acclimatized to a synthetic mechanistre from added dead bacteria (Dinhim, Jour Comp Path and Therap, 47, 1933, 157; Watson, Canad Pub Health Jour, 25, 1935, 263

Colonies on glycerol agar containing heat-killed Mycobacterium phler: After 4 to 6 weeks, just distinguishable, iluliwhite, raised, circular colonies.

Colonies on Dorset's glycerol egg contaming heat-killed Mycobacterium pher. After 4 to 6 weeks, minute, dull-white, rised, circular, with a thin, slightly irregular margin. Older colonies become more raised, radially striated or irregularly folded and dull yellowish-white

Dorset's glycerol egg containing sheep's brain and heat-killed Mycobacterium phlei Growth slightly more luvuriant.

Glyeerol broth containing heat-killed Mycobacterium phlei. Thin surface pelhele which later becomes thickened and folded.

Dorset's synthetic fluid containing heat-killed Mycobacterium phlei: As on glycerol broth with Mycobacterium phlei. Pathogenicity Produces Johne's dis-

rangementy Produces Joine 8 discase, chrone distribes, in cattle and sheep Experimentally it produces a similar disease in bovine animals, sheep and goats. Guines pigs, rabbits, rats and mice are not infected Very large doses in laboratory animals produce slight nodular lesions comparable with those produced by Mycobacterium pilita.

Antigenie structure Johnin, prepared as tubereulin, gives positive reactions in cattle with Johne's disease. According to MPFadyean et al (Jour Comp Path, and Therop. 29, 1916, 62) tubereulius animals may also give a reaction. Plumb (Den. Kong. Yet. Landbobdjskale). Arsak, 1925, 63) has shown that a resction may be produced in animals sensitived to avian tubereulin and that avian tubereulin causes a reaction in some animals infected with Johne's lacellus.

Distinctive characters: A small acidfast bacillus producing characteristic lesions in cattle and growing only in the presence of dead acid-fast bacilli.

Source From the intestinal mucous membrane of cattle suffering from chronic diarrhea Apparently an obligate paraste.

Halatat The cause of Johne's disease, a chrome diarrhea in cattle. The bacteria are found in the intestinal mucosa. Not pathogenic for guinea pigs or rabbits

4 Mycobatterium leprae (Armauer-Hinsen) Lehmann and Neumann. (Racullus leprae Armauer-Hansen, Norsk Mag Laegevidensk., 9, 1874, 1; Arch. f. path Anat. u. Physiol, 79, 1879.

32; Nord. Med. Ark., 12, 1880, 1, Quart. Jour. Micro. Sci., 20, 1850, 92; Coccohrist. leprae Lutz, Dermatol. Stud. 1, 1886, quoted from DeToni and Trevisan, in Saccardo, Sylloge Fuagorum, 3, 1889, 944; Lehmann and Neumann, Bakt. Diag, 1 Aufi., 2, 1896, 372; Discomptes leprae Neveu-Lemaire, Précis Parasit Hum., 5th ed., 1821, 27; Sclenothriz leprae Vuillemin, Eacyclopédie Mycologique, Paris, J. 1921, 135; Mycobacterium leprae hominus Lowe, Internat Jour. Leprosy, 5, 1937, 312) From Greek lepra [Propsy]

Common name: Leprosy bacillus. Armauer-Hansen (loc. cit ) was the first to observe the bacilli in the tissues of lepers The disease is now known as Hansen's disease. The bacilli occur in enormous numbers in lepromatous (nodular) cases of the disease and sparsely in the neural form. The present bacteriological means of identification depend on: (a) acid-fast staining, and (b) failure of the organism to grow in bacteriological media or in laboratory animals. Heated suspensions of the bacilly (obtained from nodules) produce a positive lepromin reaction in 75 to 97 per cent of normal persons and of neural cases of leprosy, but usually produce no reaction in lepromatous individuals (Mitsuda: See Hayashi, Int Leprosy, 1, 1933, 31-38) The failure of lepromatous persons to respond to mjected leprosy bacilli constitutes a fundamental criterion for testing the validity of microorganisms such as other acid-fast or diphtheroid cultures which can at times be recovered from leprous tissues by inoculation of bacteriological media.

Many organisms have been isolated from leprons tissues, some of which are acid-fast and have been styled Myro-bacterum leprae The strains which have been adequately studied have proven to fall into the saprophytic groups (see No. 11, Mycobacterum spp.) Hanks (Int. Jour. Leprosy, 9, 1911, 275-28) found that acid-fast cultures of this

type, as well as the diphtheroids which also have repeatedly been isolated from leprosy, were recoverable only from lesions located proximally with respect to open utcers in the shin.

Description of organisms seen in leprosy tissue from Armauer-Hansen (loc. cit.) and Topley and Wilson (Princip. Bact. and Immun., 2nd ed., 1936, 316).

Rods: 0 3 to 0 5 by 1 to 8 microns, with parallel sides and rounded ends, staining evenly or at times beaded. When numerous, as from lepromatous cases, they are generally arranged in clumps, rounded masses or is groups of barill side by side. Strongly acid-fast, Grampositive.

Pathogenicity: The communicability of leprosy from man, to man is accepted (Rogers and Muir, Leprosy, 7nd ed., Baltimore, 1919, 200 pp.). Experimental transmission to humans or to animals has not been successful.

Source: Human leprous lesions. In the lepromatous form of the disease bacilli are so abundant as to produce stuffed-cell granulomas; in the tuberculoid and neutral lesions they are rate.

Habitat: Obligate parasite in man Coafined largely to the skin (aspecially to convex and exposed surfaces) and to peripheral nerves. The microorganisms probably do not grow in the internal organs.

5 Myrobacteriua lepraemurlum Marchowa and Sord. (Bacillus der latten-lepra, Stelanday, Cont. f. Bakt., I Abt., Orig., 35, 1903, 181; Alyobacterum leprae murium Marchowa and Sord. Ann Irst. Past., 26, 1912, 700; Bacillus leprae ruirum Mutie and Henderson, Indian Jour. Med. Res., 15, 1927, 15.)

Mycobacterium pulaiforme Marchov (Ann Derm. 1921, No. 21 and Ann Inst. Past., 37, 1923, 318) from leprospikle lesions in a man from Hayti is thought by the author to be identical with Mycobacterium iprocumurium Common name: Rat leprosy bacillus

Rods. 3 0 to 5 0 microns in length with slightly rounded ends. When stained, often show irregular appearance. Strongly acid-fast Gram positive

Like the human leprosy bacillus, this organism has not been cultivated in vitro; but can be passed experimentally through rats and some strains of mice Distinctive features. The heat-killed

Distinctive leatures fine fractions in legislating bacilli produce lepromin reactions in lepratomous humans. The bacilli from lesions are not bound together in clumps, rounded masses and palisades as in human lesions. For further details see review by Lowe (Internat Jour Leprosy, 5, 1937, 310 and 463)

Source. An endemic disease of rate in various parts of the world, having been found in Odessa, Berlin, London, New South Wales, Hawaii, San Francisco and elsewhere

Habitat The natural disease occurs chiefly in the skin and lymph nodes, causing induration, alopecia (loss of hair) and eventually ulceration

6. Mycobacterium piscium Bergey et

al (Bacullus tuberculosis piscium Dubard, Bull. acad. de méd. 3 sér. 38, 1897, 689; Bataillon, Dubard and Terre, Compt rend Soc Biol., 4, sér. 10, 1897, 446; Bergey et al., Manual, 1st ed. 1923, 375) From Latin piscis, fish

Description from Bataillon et al. (loc cit.) and Aronson (Jour. Inf. Dis, 59, 1926, 319).

Slender rods, occurring singly and in threads, occasionally showing bronching Acid-fast. Non-motile. Gram-positive

Agar colonies: Small, circular, white, moist, with lobate margin and fine granular surface.

Agar slant : Scant, white, moist, crearchike.
Glycerol agar colonies: Thin, flat,

smooth, glistening, yellow.

Dorset's egg medium: Flat, smooth,

most, greenish

Broth: Thin pellicle, with flocculent sediment.

Litmus milk: Thickened. No coagulation. Slightly alkaline.

Potato White, warty, butyrous coloies.

Carbohydrates: Utilizes glucose and fructose but not sucrose, lactose, arabinose or galactose (Merril, Jour Bact, 20, 1930, 235, based on examination of one strain).

Antigenie structure: By agglutination and complement fixation (Mudd, Proc. Exp Biol, and Med., 28, 1925, 569; and Furth, Jour. Immunol, 18, 1928, 286) Mycobacterium piscium has been distinguished from Mycobacterium ranami, Mycobacterium ranami Aryobacterium ranami Prom the Inmited number of cultures examined it is not cyrident whether this is due to species or strain specificity.

Pathogenicity: Experimentally produces tubercles in carp, frog and lizard, but not pathogenic for rabbit, guines pag or birds (Dubard, Rev. de la Tuberc, \$\delta\_1\$ 1898, 13). Not pathogenic for salt water fish evcept cels (Betegh, Cent. f. Bakt., I Abt., Orig., \$\delta\_5\$, 1910, 374; \$\delta\_4\$, 1910, 211)

Distinctive characters: Mycobacterium pictum, Mycobacterium marium, Mycobacterium marium, Mycobacterium rane, Mycobacterium fidamonnic constitute a closely related group—possibly one species. They differ from other members of the gaus in their pathogenicity for cold-blooded animals, their failure to survive 80° Co ran hour, their failure to grow at 47°C and their inability to diffice sorbitoling and their inshifty to diffice sorbitoling.

Mycobacterium marrium is dustinguished by its diffuse growth in broth, acid production in milk and deep yellow to oronge pigmentation on most media. The other species grow in horth as a pellicle and render milk alkaline. Mycobacterium pieculum, Mycobacterium ranea, Mycobacterium thamnophoes and Mycobacterium friedmannii may be distinguished from each other by their habit of growth on solid media. But relatively few cultures have been studied and the reports in certain important respects are conflicting, especially concerting pigmentation and utilization of carbohydrates. Aronson, Mudd and Purth found them to differ antigenically, but too few rultures were used to distinguish between species and strain specificity.

Source: From tubercles in carp.

Habitat: The cause of nodule and tumor-like formations in carp (Ciprinus carpio). Infectious for carp, frogs, lizards. Not infectious for guinea pige and pigeons.

 Mycobscterlum marinum Aronson.
 (Jour. Inf. Dis., 39, 1926, 315.) From Latin marinus, marine.

Description from Aronson (loc. cil.).

In lesions, short, thick, uniformly staining organisms are seen frequently occurring in clumps, while long, thin, bended or barred rols are scattered more discretely. In cultures the organisms have the same appearance. Non-motile. Acid-last and acid-alcohol-fast. Grampositive

Agar slant (slightly acid): In five to seven days, most, glistening, elevated colonies, becoming lemon-yellow.

Gelatin, Not houefied

Agar colonies: In 5 to 7 days, smooth, moist, slimy, lemon-yellow, later orangecolored.

Glycerol agar colonies. In 11 to 18 days, grayish-white, moist, clevated with irregular margins. Old growths lemonyellow and still later orange-colored. Dorset's and Petroff's egg media

Similar to growth on glycerol agar but more luxuriant.

Broth and glycerol broth: Growth is diffuse, no pellicle formed.

Litmus milk Acidified and coogulated.
Indole not formed.

Indole not formed. Nitrates not produced from mirates.

Carbohydrates Utilizes arabinose and fructose, fails to utilize sorbitol and galactose (Gordon, Jour. Bact, 54, 1937, 617).

Aerobie, facultative.

Optimum temperature 18° to 20°C. Fails to survive 60°C for 1 hour, fails to grow at 47°C (Gordon, Jour. Bact., 54, 1937, 617).

Pathogenicity: Experimentally infects salt water fish, goldfish, frogs, mice and pigeons, but not rabbits or guinea pigs.

Antigenic structure: By agglutination and complement fixation distinguished from Mycobacterium renne, Mycobacterium friedmannii, and probably Mycobacterium friedmannii, and probably Mycobacterium friedmannii, 25, 1925, 509; Furth, Jour. Immunol., 12, 1926, 288). See Mycobacterium piacium.

Distinctive characters : Sec Mycobacte-

rium piscium.

Source: From areas of focal necrosis of the liver of sergeant majors (Abudeful mauritii), croakers (Micropogon undulatus) and see bass (Centropristes striatus). Habitat: Causes spontaneous jubercu-

losis in salt water fish.

S. Mycobacterium ranae (Küster) Bergey et al. (Kuster, Munch. med. Wchnachr., 52, 1905, 57; Bergey et al, Manual, 1st ed., 1923, 374.) From Latin rana, frog.

Description from Kuster (loc cit), Bynoe (Thesis, McGill University, Montreal, 1931) and Aronson (Jour. Inf. Dis.,

44, 1929, 222).

Stender rods, 0.3 t. 0.5 by 2 to 6 wicrons, smaller in 1d cultures. Uniformly acut-fast in cultures 2 weeks old or older. In younger cultures the staring is irregular, many organisms are not scid-fast. Non-motile. Gram-positive. Gelstin stab: No liquefaction.

Agar colonies: Irregular, raised colonies, 1 to 3 mm in diameter with most glistening surface, later becoming coarsely granular.

Agar slant: Thick, spreading, glistening. In old cultures dry and scaly. Putrid odor Grayish-white.

Clycerol agar colonies Similar to gelatus colonies but slightly creamy and becoming dry and wrinkled in old cultures. Dorset's egg medium: Spreading, raised, glistening, later wrinkled

Loeffler's medium: Similar to Dorset'a egg medium, white to buff-colored

gg medium, white to buff-colored Litmus milk: Becomes alkaline

Glycerol broth. Grayish flaky pellicle which breaks up carly and settles Broth. Slightly turbid, with slight

sediment.
Potato . Scanty, grayish growth, raised

with a warty surface.

Indole not formed.

Nitrites are produced from nitrates.

Carbohydrates: Glucose, fructose and arabinose are utilized; sucrose, lactose and galactose not utilized (Merrill, Jour. Bact. 20, 1930, 223) Fructose, mannutol and trehalose are utilized; sorbitol, arabinose and galactose are not utilized (Gordon, Jour. Bact. 34, 1937, 917)

No 11,8 formed.

Optimum temperature 28°C (Kuster), 37°C (Bynce).

Optimum pH 66 to 73, range 40 to 100

Antigenie atructure. By agglutinston and complement fivation Mycobacterum ranae may be distinguished from Mycobacterum puerum and Mycobacterum pretum and Mycobacterum firedmanni (Nudd, Prec Sec Exp Biol. and Med, 23, 1925, 569, Furth, Jour Immuool., 13, 1926, 286). See Mycobacterum puerum

Pathogenicity. Experimentally causes tuberculosis in frogs, lizards, turtles, not pathogenic for rabbits, guinea pigs, rats or mice.

or mice.

Distinctive characters See Mycobac-

Source . From the liver of a frog.

tersum piscsum.

Habitat: In a group of 215 cultures belonging to the genus, isolated from soils, Gordon (Jour Bact, 51, 1937, 617) found 65 to sufficiently resemble Mycobacterium ranae to indicate at least a very close relationship. If they prove to be identical, the species is widely distributed.

Mycobacterium thamnopheos Aronson (Jour. Inf. Dis., 44, 1929, 222)
 I'rom Thamnophis, a genus of snakes.

Tuberculhacillen bei Schlangen, Sibley, Arch. f. pathol Anat. u. Physiol., 116, 1889, 101 (Mycobacterium tropidonatum (sic) Bergey et al , Manual, 1st ed., 1923, 376) is probably identical, but the descriptions are too meager to be conclusive Acid-fast bacilli described by Gibbes and Shurley (Amer. Jour. Med. Sci. 100, 1800, 145) as the cause of tuberculosis in boas and pythons; by Shattock (Trans Path. Soc., London, 55, 1902, 430) and by von Hanseneann (Cent f Bakt, I Abt, Orig, \$4, 1903. 212) as eausing tuberculosis in a Python molurus, are possibly identical, but the descriptions do not permit us to draw any conclusions. According to Aronson, similar organisms isolated from pathological leaions in boa constrictors and Caluber catenifer differ antigenically from Mucobacterium thamnopheos.

Description taken from Aronson (loc. cit.) and Bynoe (Thesis, McGill University, Montreal, 1931).

Stender rods 0.5 by 4 to 7 microns, frequently alightly curved, beaded and barred forms frequently occur. Non-motile Acad-fast in cultures of 4 days or older, in younger cultures aome organisms are not acid-fast. Not alcohol-fast Gram-positive.

Gelatin stab: Growth occurs along the 'line of moculation. No liquefaction

Agar colonies 0 5 to 1 mm in diameter, irregular, raised, moist and glistening.

Glycerol agar Spreading, raised, dry, pale pink to buff growth.

Glycerol broth A thin pellicle appears in 5 to 6 days, gradually becomes thicker and falls as a sediment.

Dorset's egg medium: Raised, moist, pinkish growth after 10 days, later becoming salmon-colored.

Loeffler's serum: Small, raised, convex, dry growth

Litmus milk: Alkalıne

Glycerol polato: Raised, hemispherical, dry and granular growth.

Indole not produced.

Nitrates: Not reduced by 2 strains.

reduced by 1 strain (Aronson); slightly reduced (Gordon); not reduced (Bynoe).

Carbohydrates: Utilizes fructose, mannitol and trehalose; fails to utilize arabinose, sucrose, galactose and sorbitol (Gordon, Jour. Bact., \$4, 1937, 617).

Temperature relations: Fails to survive 60°C for 1 hour, fails to grow at 47°C (Gordon); good growth at 25°C, no growth at 37°C (Aronson); optimum for growth 25°C, range 10° to 35°C (Bynoe).

Range of pH · 6.6 to 7.8 (Aronson); optimum 7.3 to 8.0, range 50 to 11.0 (Bynoe).

Pathogenicity · Experimentally produces generalized tuberculosis in snakes, frogs, lizards and fish but not pathogenic for guines pigs, rabbits or fouls.

Antigenic structure; By agglutination and absorption of agglutinins Mycobacteroum thamnophees may be distinguished from Mucobacterium marinum, Mycobacterium friedmannsi and Mucobacterium range. See Mycobacterium piscium.

According to Bynoe and Variation Wyckoff (Amer. Rev Tub., 29, 1934, 389) S and R forms may be distinguished by colony structure and individual cell orrangement.

Distinctive characters: See Mucobac-

terium piscium.

Source: From the lungs and livers of garter snakes (Thamnophis sirtalis).

Habitat · Present as a parasite in the garter snake and possibly other coldblooded vertebrates.

10. Mycobacterium friedmannii Holland. (Schildkroten tuberkelbaeillus, Friedmans, Cent f Bakt, 1 Abt, Orig., 34. 1903, 647; Bacillus friedmann (sic) Holland, Jour. Bact., 5, 1920, 218; Mycobacterium friedmanti Holland, ibid; Mycobacterium chelones Bergey et al., Manual, 1st ed., 1923, 376-) Named for Dr. Friedmann, who isolated this organiam.

Common name. Turtle bacillus.

Description from Friedmann cit.) and Aronson (Jour Inf. Dis , 44, 1929, 222).

Slender rods: 0.2 to 0 4 by 0.5 to 5 microns. Beaded forms are common, Acid-alcohol-fast in young cultures but in cultures two weeks old generally there are many non-acid-fast rods. Non-motile. Gram-positive.

Gelatin stab: White surface growth, scanty growth along the line of stab. No liquefaction.

Agar colonies: 1 to 3 mm in dismeter,

irregularly round, raised, moist, glistening, white, Glycerol agar slants: Thick, spreading

growth, at first moist, later granular, yellowish-white (Friedmann), olive-gray (Bynoe); white (Aronson).

Glycerol broth: Thick wrinkled pellicle

after two to three days growth, later some membinious sediment. Gravishyellow (Friedmann): grayish-white (Bynoe).

egg medium: Spreading, Dorset's raised, slightly moist, pale bull.

Loeffler's serum: Scant growth, raised, dry, crumb-like. Litmus milk: Slightly alkaline after

10 days growth. Glycerol potato: Thick, wnnlied, gray

after 2 days growth.

Indole not formed.

Carbohydrates: Glucose, fructose and arabinose utilized, sucrose slightly utilired, galactose and lactose not utilized (Merrill, Jour. Bact, 20, 1939, 235). Arabinose not utilized (Gordon, Jour. Bact., 34, 1937, 617)

Optimum temperature 25° to 30°C.

Pathogenicity: Experimentally produces tubercles in most species of coldblooded animals, possibly in guinea pigs but not in other warm-blooded animals.

Variation: According to Gildemeister (Cent. f. Bakt., I Abt., Orig., 86, 1921, 513) S and R types may be distinguished on glycerol agar. The S grows as smooth, moist, glistening, convex colonies; the R as flat, dry, spreading colonies. Wykoff (Amer. Rev. Tub., 29, 1934, 289) has shown a difference in the form of cell division and corresponding cell arrangement of the two types.

Distinctive characters: See Mycobacterrum piscium.

Source. From the lungs of turtles in

the Berlin aquarium.

Habitat: A parasite in turtles and possibly sparingly distributed in soils. Gordon (Jour. Bact , \$4, 1937, 617) found 65 out of 215 soil cultures of members of the genus to closely resemble this species.

11. Mycobacterium spp. (A miscellaneous group many of which have been incorrectly identified as Mucobacterium lepras Lehmann and Neumann )

Clegg (Phil. Jour. Sci., 4, 1909, 77 and 403), Duval (Jour, Exp. Med , 12, 1910, 619). Duval and Wellman (Jour Inf Dis . 11, 1912, 116), Gurrie, Brinckerhoff and Hollmann (Pub Health Rep., 25, 1910, 1173) and others have described as Mucobacterium leprae a group of organisms isolated from leprosy lesions evidence, summarized by McKinley (Medseine, 13, 1934, 377), points to the conclusion that these organisms are not nathogenic and not the causal agent of leprosy They cannot therefore be included under Mucobacierium leprae as defined above

Thomson (Amer. Rev Tub , £0, 1932, 162), Gordon (Jour. Bact., 34, 1937, 617), and Gordon and Hagan (Jour Bact., 56, 1938, 39) recently separated the saprophytic members of the genus Mucobacterrum into three main groups and several subgroups Species names as here defined have been added to the key as follows:

Group I. Fail to survive 60°C for 1 hour. Grow at 47°C. a. Utilizes arabinose.

Mycobactersum lacticola.

b. Unable to utilize arabi-Mucobacterium sp.

Group Il Fail to survive 60°G for 1 hour. Do not grow at 47°C

a. Unable to utilize sorbitol. I. Unable to utilize arabinose.

Mucobacterium ranae. Myeobacterium thamno-

pheos. Mucobacterium sp.

2. Utilize arabinose. Mucobacterium inum.

Mycobacterium sp.

b Utilizes sorbitol. Mycobacterium spp.

c Unable to utilize most carbohydrates.

> Mycobacterium friedmannei.

Mucobacterium sp.

Group III Survive 60°G for 1 hour. Grow at 47°C.

> a. Utilizes arabinosa. Mucobacterium phies.

b. Unabla to utiliza arabi-

BOSG. Mucobacterium sp.

In this study Gordon and Hagan included many recently isolated soil forms. named saprophytic apecies, pathogens for cold-blooded animals and 19 cultures. from various collections, which bore the name Mycobacterium leprae. Of these so-called Mucobacterium leprae, six bolong to Group I which corresponds with Mucobacterium lacticola and includes many soil forms, two belong to Group Ha which includes Mycobacterium range. Mycobacterium thamnopheos and a number of undefined soil forms, while eleven belong to Group 11b. The latter group includes a number of soil cultures but no other defined anecies.

In the several groups to which so-called Mycobacterium leprae strains belong, some appear to be indistinguishable from soil forms, others are distinguished by habit of growth, utilization of carbobydrates or by pigmentation

12 Mycobacterium lacticola Lehmann and Neumann. (Bakt. Diag , 2 Aufl., 2. 1899, 409.) From Latin lac, lactis, milk and colo, to dwell; hence, a milk dweller.

From the fact that Lehmann and Neumann (loc. cit., 411) refer to the binomial Bacillus friburgensis Korn, it is evident that the species name friburgensis (see Appendix) published the same year (1899) has priority over the species name lacticola. However, since it has never been used with the broad meaning given Mycobacterium lacticola by Lehmann and Neumann in the original description, it is not substituted for the more commonly used Mycobacterium lacticola in this edition of the Manual.

Description from Lehmann and Neumann (loc. cit) and Jensen (Proc. Linnean Soc. of New So. Wales, 59, 1934, 19).

Slender rods: 0.5 to 0.7 by 2 to 8 microns in young cultures, in older cultures the rods are shorter and frequently eoceoid in shape. Curved and irregular forms occur occasionally. Branched forms, if they occur, are very rare Staming is generally uniform but slight beading occurs occasionally. Strongly acid-fast evcept organisms from glucose-containing media which are sometimes only faintly acid-fast. Cram-positive

Gelatin colonies. Similar to those on agar.

Gelatin stab: Filiform growth in stab. No liquefaction

Agar colonies: Convex, glistening, with entire margins, at first smooth but after 10 to 14 days growth folded or wrinkled Opaque, at first white, after 2 or 3 days growth becomes yellow

Glucose agar Similar to agar but more rapid growth and less intensely pigmented.

Glycerol agar slants Spreading, moist, wrinkled, pale cream-colored to yellow.

Nutrient broth. Diffuse growth, later with vellowish pellicle

Litmus mulk. Small white granules of growth at the surface, later a dry yellowish pellicle. After some weeks' growth the milk becomes alkaline and clear No coagulation Dorset's egg medium. As on glycerol agar.

Coagulated serum: As on glycerol agar.

Potato: Spreading, raised, winkled
growth, pale yellow to grange.

Long's medium lacking glycerol: No growth. Long's medium with 5 per cent glycerol: Acid formed. (Thomson, Amer. Rev. Tub., 26, 1932, 162.)

Indole not formed.

Nitrates: Reduced, doubtful (Jensen). Carbohydrates: Clurose, fructuse, ambinose and galactose are utilized; lactose is not utilized; lactose is not utilized; sucrose is not utilized by a strains, utilized by 1 strain (Mycobacterium friburgenats) (Merrill, Jour. Bact, 20, 1930, 235). Sorbitol, ambinose, galactose, trehalose, mannitol and fructose are utilized; sucrose is not utilized (Gordon, Jour. Bact, \$4, 1937, 617).

Optimum temperature 37°C, maximum temperature for growth 52°C, minimum 15° to 15°C. Falls to survive 60°C for 1 hour, grows at 47°C (Gordon, Jour. Bact., 54, 1937, 61°; Gordon and Hagan Jour. Bact., 52, 1938, 39).

Optimum pH 6.8 to 7.2. Limits for growth 4.5 to 100.

Distinctive characters: Saprophytic scid-fast organism. Grows rapidly on most media, develops a yellow or orange pigmentation after 3 to 4 days groath. Fails to grow on Long's medium lacking glycerol and produces acid when slycerol spresent. Fails to survive 60°C for an hour, grows at temperatures as high as

Variation. Lehmann and Neumann (Bakt. Diag., 2 Audl., \$, 1899, 405) and Haag (Cent. I Bakt., II Abt., 71, 1927, I) describe three forms: a flat smooth form, a moist, slimy, smooth form and a dry.

The two forms:

with R

tic of Mycobalterian Mycobacterium betolinensis, Mycobacterium butyricum and Mycobacterium graminit which in turn correspond with S and R types of other members of the gen Schwabacher (Spec. Rep. Ser. Med. Ret Coun., London, No. 182, 1933) finds a difference in the arrangement of the individual cells of the S and R types.

Source · From butter, plant dust, cow

manure.

Ilabitat: Gordon (Jour Bact, 34, 1937, 617) found 1 culture isolated from nasal evudate, 1 from bovine lymph gland and 91 isolated from soil, out of a group of 215 soil cultures belonging to the genur, to be either identical with or very closely related to this species II these atmins are valid members of the species, Mycobacterium lacticola is widely distributed in soil, dust, dury products, etc

13 Mycobaterium phlei Lehmann and Neumann (Timotheobacillus or Grasbacillus I, Moeller, Therapeutischen Monataheften, 12, 1828, 607, Moeller, Deut med. Wehnschr, 24, 1898, 376, Lehmann and Neumann, Bakt Diag, 2 Aufl. 2, 1899, 411, Mycobaterium maelleri Chester, Manual Determ Bact, 1901, 385, Selerolhriz phlei Vullemm, Eneçdopédne Mycologique, Paris, 2, 1931, 160) From M. I. Phleum, a genus of grasses

Description from Moeller (loc cit) and Jensen (Proc Linnean Soc New So Wales, 69, 1934, 32)

Slender rods 0 2 to 0 5 by 1 to 4 merons, sometimes club-shaped, frequently braded, rarely branched Strongly send-fast and acid-alcohol-fast in cultures older than 2 to 3 days, in younger cultures there are generally many non acid-fast cells. Non-notitle. Gram-positive cells.

Gelatin colonics Small, 0.5 to 1 mm in diameter, irregular, raised, moist and glistening, finely granular, orange Gelatin stab Filiform, opaque, orange

No liquefaction.

Agar colonies Similar to gelatin colo-

nies, yellow to orange.

Agar slant. Spreading, raised, dry with
roughened granular surface, yellow to
orange

Broth Turbid, with yellow pellicle. Dorset's egg medium: Spreading, raised, dry, orange. Loeffler's serum. Similar to Dorset's egg medium, ereamy to yellow.

Glycerol broth: Thin transparent pellicle, later becoming thickened, rough, wrinkled and yellow to pink, still later a flaky sediment.

Latmus milk: Yellow floccult on surface, slowly becomes alkaline. No coagulation.

Potato: Thick, dry, yellow, adherent growth.

Long's medium lacking glycerol: Abundant growth Long's medium with 5 per cent glycerol. No acid formed (Thomson, Amer Rev Tub., 26, 1932, 162).

Nitrites are produced from mitrates. Indole not formed.

Carbohydrates Clucose, fructose, arabinose, trehalose, mannitol and galactose are utilized; sucrose and lactose are no utilized (Merrill, Jour Bact., £0, 1030, 235. Cordon, Jour. Bact., £1, 1937, 617)

Temperature relations Survives 60°C lor 1 hour, grows at 47°C (Thomson, Amer. Jour Tub., 20, 1032, 162); optimum for growth 37°C, range 20° to 53°C (Bynoe)

Optimum pH 6 8 to 7.3; range 5.5 to 10 0

Pathogeneity The injection of large numbers of organisms into guinea pigs results in a local abscess of a few week? duration, occasionally small abscesses develop in the regional lymph glands or the visceral organs. According to Mayer (Cent I Bakt, I Abt, 28, 1879, 331) and others, the injection of the organism along with butter or other fat increases the pathogeneit reaction.

Variation Hang (Cent f Bakt, II bbt, 71, 1927, 1) and Bynoe (Thesis, McGill University, Montreal, 1931) find two or three colony types an R form which fits into the description of the species given above and an S type which grows as a perfectly smooth, raised, most, glistening colony with an entire margin. Cooper (Jonr In Dis. 34, 1934, 239) distinguished pigmented and son-pigmented types.

Distinctive characters: Saprophyti acid-fast organism, grows rapidly on most media. Shows yellow pigmentation as soon as growth is visible. Grows well on Long's medium lacking glycerol and fails to produce acid when glycerol is present. Survives 60°C for 1 hour and grows at 47°C.

Source: Originally isolated from hay and grass. Frequently found in soil, dust and other sources. Out of 215 cultures of the genus recovered from soils by Gordon (Jour. Bact., 34, 1937, 617) Mycobacterium phies was isolated on 22 occasions. The same author reports 3 cultures of a closely related if not identucal organism recovered from bovine lymph glands, I recovered from bovine skin and I recovered from a hen's spicen.

Habitat: Widely distributed in soils, dust, hay, etc.

Appendix I: The following saprophytic species have been placed in this genus. Their relationships are not clear. Some are related to or possibly identical with Mucobacterium tacticula

Mycobacterium album Söhngen. (Cent. f. Bakt., II Abt., 57, 1913, 599.)

From garden earth

Mycobacterium bekkern Bekker. (Autonie van Leeuwenboek, 9, 1943, 81; abst. in Cent. f. Bakt, I Abt., Orig, 149,

1944, 500.) From urine.

Mycobacterrum berolinense Bergey et al (Tuberkedanlichen Bacillen, Rabinowitsch, Zischr I Hyg., 28, 1837, 90; Mycobacterium lacticola 5 perrugosum Lehmean and Neumann, Bakt. Disg., 2 Aufl., 2, 1899, 410; Mycobacterium lacticola perrugosum Haag, Cent I. Bakt.,

includes both the Tuberkelahnlichen Bacillen of Rabinowitsch and the Butter Bacillus of Petri. From butter.

\*\* 1D

Mycobacterium butyricum Bergey et al. (Butter Bacillus, Petri, Arb. kaiserl. Gesundholtsamte, 14, 1898, 1; Bergey et al., Manual, 1st ed., 1923, 377.) From butter.

Mycobactersum 'cholesterolicum Tak. (Antonie van Leeuwenhoek, 8, 1942,

39) From garden soil.

Mycobacterium friburgensis (Kon) Chester. (Bacillus friburgensis Kon, Cent. f. Bakt., I Abt., 25, 1899, 532; Mycobacterium lacticola y friburgensis Lehmann and Neumann, Bakt. Dig., 2 Aul., 2, 1899, 411; Chester, Man. Detem. Bact., 1901, 359) From butter.

Mycobacterium praminis Chester. (Grashacillus II, Moeller, Cent f. Batt., I Abt., 25, 1899, 369; Mycobacterium lecticola a planum Lehmann and Neumana, Bakt. Diag., 2 Auf., 2, 1899, 408; Chester, Man. Determ Bact., 1901, 339; Myrobacterium lacticola planum Haag, Cent. f. Bakt., 11 Abt., 71, 1927, 3.) From hay dust.

Mycobacterium hyalinum Sohngen. (Cent. f. Bakt., II Abt., 37, 1913, 599)

From garden earth.

Mycobacterium luteum Sohngen (loc. cit.). From garden earth.

Mycobacterium muris Simmons. (Jour. Inf. Dis., 41, 1927, 13.) From the

feces of gray mice.

Mycobacterium phlei perrugosum Haag
(Cont. f. Bakt., II Abt., 71, 1927, 6)

From soils and manure.

Mycobacterium phlei planum Hasg (loc

cit.). From soils.

Mycobacterium ranicola I and II Hang

Mycobacterium ranicola I and II 11839 (loc. cit.). From frogs.

Mycobacterium rubrum Söhngen (loc.

cit.). From garden earth.

Mycobacterium snegmatis (Trevisan)
Chester (Sanegma bacillus, Alvarzi
and Tavel, Arch. Phys. norm et piath,
g. 1825, 303; Bacillus snegmatis Trevisan,
I generi e le specie delle Batteriace,
1830, 14; Bacterium snegmatis MigdisSyst d. Bakt, g. 1900, 497; Chester,
Man. Determ. Bact., 1901, 357. From
snegma Weber (Arb. Kaiseri, Gesuadhettsamte, 19, 1902, 251) finds Mycobacterium snegmatis acid- but not alcoholfest in contrast to the mammalisa

tubercle bacill which are both acid-and alcohol-fast. Later observers (Bynoe, Thesis, McGill University, Montreal, 1931) have not found this a valid distinction

Mycobacterium smegmalis var muris Galli-Valerio (Cent. f. Bakt, I Abt, Orig, 75, 1915, 49.) From the preputial glands of the black rat (Mus rattus)

Mycobacterium stercoris Bergey et al. (Mist Bacillus, Moeller, Berlin, therfartil, Wochnachr, 1898, 100; Mycobacterium stercusis (sic) Bergey et al., Manual, 1st ed, 1923, 378; Bergey et al., Manual, 4th ed, 1934, 512) From manure.

Mycobacterium testudinis Friedmann and Prorkovski. (See Hang, Cent f Bakt, II Abt., 71, 1927, 5; apparently the same as Mycobacterium testudo, loc cit, 10.) This is probably Mycobacterium friedmannii. From turtles

Appendix II: Krassilnikov (Mikrohiol, 7. 1938, 335; and Ray Fungs and Related Organisms, Izd. Acad. Nauk. Moskow, 1938, 121-130) describes a genus Mycoccus distinct from Hansgurg's (Österr. Bot. Zischr., 28, 1888, 285) family Mycoccucacae (nhich is related to the fungi) and distinct from Mycocccus Bokor (Arch. I. Mikrobiol., 2, 1930, 1).

1, 1930, 1). Mucococcus Krassılnikov species that produce coccus-like cells, genetically related to the species included in Mucobacterium; reproduction is by fission or budding in different directions, often forming short, irregular chains with side branches: In old cultures, the veretative cells change into resting cells, the latter germinating in a manner similar to the spores of actinomycetes. Seven species are listed, with incomplete descriptions. Mucococcus ruber. M. capsulatus, M luteus, M. citreus and M. albus are described in Krassilnikov's original paper. One of these (Mycococcus luteus) is dropped in his later monograph while descriptions of two new species are added (Mucococcus tetragenus and M. mucosus).

# FAMILY II. ACTINOMYCETACEAE BUCHANAN,\*

(Jour. Baet., 3, 1918, 403.)

Mycelium is non-septate during the early stages of growth but later may become septate and break up into short segments, rod-shaped or spherical in shape, or the mycelium may remain non-septate and produce spores on aerial hyphae. The organisms in culture media are either colorless or produce various pigments. Some species are partially acid-fast. This family is distinguished from the previous one by the formation of a true mycelium. As compared with the next family, it is characterized by the manner of spore formation.

# Key to the genera of family Actinomycetsceae.

I Obligate acrobie. The colonies are hacteria-like in nature, smooth, rough or folded, of a soft to a dough-like consistency, sometimes compact and leather in young stages. Most forms do not produce any acrial mycelium; a few produce a limited mycelium, the branches of which also break up into oldiospers or segmentation sporcs. Some species are partially acid-fast. Genus I. Nocardia, p. 892.

 Anacrobic or microscrophilic, parasitic; non-scid-last, non-proteolytic and nondustatic.

Genus II. Actinomyces, p. 925.

#### Genus I. Nocardia Trevisan.

(Trevisan, I generi e le specie delle Batteriacce, 1889, 9; Actinomyces Gaspenal, Cent. I. Bakt., 18, 1894, 684 and Atti dell' XI congresso med. internat. Roma, 6, 1895, 82; not Actinomyces Harz, Jahresber. d. Munch. Thieratzneischule for 1877-

Microbio

Luni, 9, revistration.

Artz Lignières, Ann. Parasit. hum et comp., 2, 1924, 1; Asterotaes a unitud and Leonardi, Boll e Atti d. R. Accad. Med., 61, 1935, 90; Proactinomyces Jonson, Proc. Linn. Soc. New So. Wales, 56, 1931, 345.) Named for Prof. E. Nocard who first described the type species.

Stender filaments or rods, frequently swollen and occasionally branched, forming a mycelium which after reaching a certain size assumes the appearance of lacterium-like growths. Shorter rods and coccoid forms are found in older cultures. Confidence from the formed Stain readily, occasionally showing a slight degree of acid-fastness. Non-motile. No endospores. Aerobic. Gram-positive. The colonies are similar in gross appearance to those of the genus Mycobacterium. Paraffin, phenol and mycropol are frequently utilized as a source of energy.

In their early stages of growth on culture media (liquid or solid), the structure of necardias is similar to that hyphae branch abundantly, refing to the species

vary between 0.5 and 1 mic.

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<sup>\*</sup> Completely revised by Prof S A Waksman, New Jersey Experiment Station, New Brunswick, New Jersey and Prof A T Henrici, University of Minnesota, Minnesota, May, 1943.

cells On fresh culture media, the coccoid cells germinate into mycelia. The whole cycle in the development of nocardias continues for 2 to 7 days. Most frequently the coccoid cells are formed on the third to fifth day, but in certain species (e.g., Nocardia rubra) they can be found on the second day.

Numerous chlamydospores may be found in older cultures of nocardias. They are formed in the same way as the chlamydospores in true fung: the plasma inside the filaments of the inyeclium condenses into elongated portions. In older cultures of nocardias many coccoid cells are changed into resistant cells. The latter are larger than the vegetative occoid cells; the plasma of these cells is thicker than the plasma of vegetative cells; on fresh media they germinate like the spores of actinomyces; they form 2 to 3 germ tubes. Besides the cells mentioned, numerous involution forms can often be found in older cultures of nocardias, the cells are thin, regularly cylindrical or occoold, are often transformed into a series of spherical or clliptical ampules and a club-like form (2 to 3 micros and more)

The multiplication of nocardias proceeds by fission and budding, occasionally they form special spores. Budding occurs often The buds are formed on the lateral surface of the cells, when they have reached a certain size, they fall off and develop into rod-shaped cells or filaments. The spores are formed by the brtaking up of the cell plasm into separate portions usually forming 3 to 5 spores, every portion becomes rounded, covered with a membrane and is transformed into a spore; the membrane of the mother cell dissolves and disappears. The spores germinate in the same way as those of actinomyces. They form germ tubes which develop into a mycelium.

The colonies of nocardias have a poste-like or mealy consistency and can easily be taken up with a platinum loop; they spread on glass and occasionally render the broth turbid. The surface colonies are smooth, folded or wrinkled. Typical norardias never form an aerial mycelium, but there are cultures whose colonies are covered with a thin coating of short serial hyphac which break up into cylindrical oidiospores.

Many species of nocardus form pigments; their colonies are of a blue, violet, red, yellow or green color, more often the cultures are colories. The color of the culture serves as a stable character.

Krassilnikov (Ray lungi and related organisms, Ital Acad Nauk, U S S R, Moscow, 1935) divides the genus into two groups 1 Well developed aerul mycelium, substrate mycelium seldom produces cross-walls, the threads break up into long, thread-like rods; branches of the serial mycelium produce segmentation spores and oldospores, the latter see cylindrical with sharp ends; no spirals of fruiting branches. This group is the same as group B of Jensen (loc et l). 2 Typical forms; mycelium declops only at early stages of growth, then breaks up into rod-shaped and occord bodies, smooth and rough colonies, dough-like consistency, never form an aerial mycelium, similar to bacterial colonies; aerial mycelium my form sround colonies. This genus cun also be divided, on the basis of send-fastness, into two groups: Group 1. Partially acid-fast organisms, which are non-proteolytic, non-divistatic and utilize parafilm, usually yellow, pink, or orange-red in color. Group 2. Non-acid-fast organisms, which are diastatic, largely proteolytic and do not utilize paraffin; yellow, orange to black in color

The type species is Nocardia farcinica Trevisan.

#### Key to the species of genus Nocardia.

1 Partially and fast\* organisms with strongly refractive cell\*, non-proteolytic and generally non-diastatic, constantly capable of utilizing paraffin.

Acid-fastness is not marked in cultures, is apparent in infected tissues, pronounced in sputum or other exudates.

A. Initial mycelium well developed, richly breaching, dividing into rods and generally into cocci. 1. Vegetative mycelium soft, without macroscopically visible aerial

mycelinm.

s. Vegetative mycelium yellow, orange or red. b. Pathorenic.

c. Vegetative mycelium white, buff, or pale yellow

1. Nocardía farcinica.

cc. Vegetative mycelium yellow to red,

2. Nocardía asteroides. bb. Not pathogenic.

3. Nocardia polychromogenes.

an. Vegetative mycelium white to pink.

Gelatin not liquefied.

c. Growth on nutrient agar opaque, cream-colored; coccoid forms in broth.

4. Nocardía opaca. cc. Growth on nutrient agar watery, no coccoid forms in broth.

5. Nocardia erythropolis.

cce. Growth on Dutrient agar pink. d. White serial mycelium on milk.

6. Nocardia leishmanii.

dd. Pink pelliele on milk. 7. Nocardia caprae.

ddd. Yellow pellicle on milk 8. Nocardia pretoriana.

bb. Gelatin liquefied.

9. Nocardia pulmonalis. 2. Vegetative mycelium hard, yellow, with white aerial mycelium; hyphse

divide into chains of acid-last cocci. 10. Nocardia paraffinae.

B. Initial mycelium very short, rapidly dividing into rods and cocci

1. Slowly growing organisms; cells 0 5 to 0.7 microa ia diameter. 11. Nocardia minima.

2 Rapidly growing organisms; cells 1 0 to 1.2 microns in diameter.

a. Growth pick.

b. Cystites (smollen cells) not formed.

c. No indigatin from indole. 12. Nocardia corallina.

cc. Indigatin from indole.

Nocardia globerula. bb. Cystites formed

14. Nocardia salmonicolor.

as. Growth comi red. 15 Nocardia rubropertincia.

ans Growth dark red 16. Nocardia rubra.

agaa. Growth white b No serial mycelium.

17. Nocardia coeliaca.

bb. Aerial mycelium. 18. Nocardia transvalensis.

- Non-acid-fast organisms with weakly refractive cells; no distinct formation of cocci. Constantly disstatic.
  - A. Not proteolytic.
    - 1. Growth on agar pale ercam-
      - Growth on agar yellow.
- 19 Nocardia mesenterica.
- 3. Growth on agar green.
- 20 Nocardia flava.
- 21 Nocardia viridis.
- Growth on agar yellow-green
   Nocardia citrea.
- 5. Growth on agar pink to erimson.
- 23 Nocardia madurae.
  6. Growth consistency soft, sparse serial mycellum.
- 24. Nocardia lutca.
- 7. Growth consistency medium, good seriai mycelium.
  23. Nocardia blackwellii.
- 8. Good action on milk. Growth consistency firm, liberal, aerial myce-
  - 26. Nocardia cuniculi
- 9. Deep brown pigment on protein media.
- 27 Nocardia rangoonensis.
  10. Light brown pigment on protein media.
- 28. Nocardia carias
- B. Proteolytic.
  - Growth on nutrient agar with ropid formation of unbranched diphtheroid-like rods; no typical cyatites; broth turbid.
    - 29 Nocardia actinomorpha.
  - Growth on nutrient agar with extensive mycelia; aimple unbranched rods not formed; cystites present. Broth clear.
     Nocardia flawszens.
  - 3. Colonies orange-yellow to orange-red, which may change to black.
    - 31 Nocardia maculata.
  - 4. Light brown pigment on protein media
    32 Nocardia rhodnii.
  - 5. Green to greenish-brown pigment on protein media.
    - 33 Nocardia aardneri.
- 1. Nocardia farcinica Trevisan. (Bacille du farcin, Nocard, Ann. Inst. Past. \*, 1888, 293; Trevisan, I generie i e specie delle Batteriaece, Milan, 1889, 9; Streptotris farcinica Rossi Doria, Ann. d Ist d'Igi Sper. Univ. di Roma, 1, 1891, 421; Actinomyees farcinicus Gasperius, Ann Ist. d'Igine, Roma, 2, 1892, 222; Osopora farcinica Sauvageau and Radais, Ann Inst. Past., 6, 1892, 218; Actinomyees bors farcinicus Gasperini, Cent. f Bakt., 15, 1891, 681; Bacillus farenicus Gas-

perini, that; Cladothris farentica Mace, Traité de Bacttrologie, 3rd ed., 1894, 1947; Streptothris farent boris Kitt, Bakternakunde und pathologische Mikroskopie, Vienna, 3 Aufl, 1899, 511; Bacternum nocardi Migula, Eyst d. Bakt, 2, 1900, 315, Streptothris nocardi Toulerton, Jour. Compt Path. and Therap. 14, 1901, 51; Discompres farcinicus Gedockt, Les champignons parasites de Phomme et des animaux domestiques, Brussels, 1902, 107; Ac. tinomyces nocardii Buchanan, Veterinary Bacteriology, Philadelphia, 1911, 378. Nocardia albida Chalmers and Christopherson, Ann Trop. Med and Parasit., 10, 1916, 271, according to Dodge, Medieal Mycology, St. Louis, 1935, 746.) From M. L. farcinicus, of farcy.

Filaments 0 25 micron in thickness. branched. Markedly acid-fast.

Gelatin colonies: Small, circular, transparent, glistening.

Gelatin stab: No liquefaction. Agar colonies: Yellowish-white, irregu-

lar, refractive, filamentous. Agar slant : Grayish to yellowish-white

growth, surface roughened. Broth · Clear, with granular sediment, often with gray pelliele.

Litmus mulk. Unchanged.

Potato: Abundant, dull, erumpled, whitish-yellow growth.

Nitrites not produced from nitrates.

No soluble pigment formed. Proteolytic action absent

Starch not hydrolyzed. Aerobie, facultative

Optimum temperature 37°C.

Source: From eases of bovine farey. Habitat: Associated with a disease in eattle, resembling chronic tuberculosis. Transmissible to guinea pigs, cattle and sheep, but not to rabbits, dogs, horses or monkeys

(Eppinger) asterotdes 2 Nocardia (Cladothrix asteroides Ep-Blanchard pinger, Beitr. z path Anat , 9, 1891, 287; Streptotrix (sic) eppingerii Rossi Doria, Ann. Inst d'Ig. sper d. Univ. Roma, 1, 1891, 423, Streptotrix (sic) asteroides Gasperini, Ann Inst d'Ig. sper. d. Univ. Roma, 2, 1892, 183; Oospora asteroides Sauvageau and Radais, Ann Inst Past., 6, 1892, 252; Actinomyces asteroides Gasperim, Cent. f. Bakt , 15, 1894, 684; Blanchard, in Bouchard, Traité Path. Gén , 2, 1895, 811, Discomyces asteroides Gedoelst, Champ. Paras Homme et Anım , 1902, 173, Actinomyces eppingeri Namyslowski, Cent f. Bakt., I Abt., Orig., 62, 1912, 566; Asteroides asteroides Puntoni and Leonardi, Boll. e Atti d R. Accad. Med. di Roma, 61, 1935, 92, Mycobacterium asteroides, quoted from Puntoni and Leonardi, idem; Proachasteroides Baldacci, Soc nomuces Internat. di Microb., Boll. d Sez. Ital, 9, 1937, 141.) From Greek aster, star and cidos, shape

Probable synonyms: Streptotrix aurantiaca Rossi Doria, loc cit., 417 (Actinomyces aurantiacus Gasperini, loc. est, 1892, 222; Oospora aurantiaca Lehmann and Neumann, Bakt. Disg , 1 Aufl , 2, 1896, 388; Cladothrix aurantiaca Mace, Traité Pratique de Bact , 4th cd., 1901, 1026; Nocardia aurantiaca Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 268) and Streptothriz frecri Musgrave and Clegg, Philippine Jour. Sci., Med. Sciences, 2, 1907, 477 (Discomyces freeri Brumpt, Précis de Parasitol., Paris, 1st ed , 1910, 858, Nocardia freeri Pinoy, Bull, Inst. Past . 11, 1913, 936; Cospora freeri Sartory, Champ. Paras. Homme et Anim., 1923, 785; Actinomyces freers Bergey et al, Manual, 1st ed., 1923, 346). According to Chalmers and Christopherson (loc. cit.) another synonym of this organism is Streptothriz hominie Sabrazes and Rivière, Le Semaine Médecine, 1895, no. 44.

Straight, fine mycelium, 0.2 micron in thickness, which breaks up into small, coccoid conidia. Acid-fast.

Gelatin stab . Yellowish surface growth No growth in stab. No liquefaction Synthetic agar : Thin, spreading, orange

growth. No aerial mycelium Starch agar: Restricted, scant, orange

Plain agar: Much folded, light yellow growth, becoming deep yellow to yellow. ish red . . ......le.

No coagulation No peptomization Potato. Growth much wrinkled, whitish becoming yellow to almost brick-red. Nitrites produced from nitrates. No soluble nigment formed. Proteclytic action doubtful. Starch not hydrolyzed.

Transmissible to rabbits and gumea pigs but not to mice.

Aerobic.

Optimum temperature 37°C. Source: From a cerebral abscess in man Habitat . Also found in conditions resembling pulmonary tuberculosis

A number of strains of acid-fast actinomycetes isolated from human lesions have deviated in certain particulars from the description of Nocardia asteroides. but not sufficiently to warrant senaration as species. The following varieties are described by Baldacci (Mycopathologia, 1. 1939, 68): Nocardia asteroides var. crateriformis

(Baldacci) comb. nov (Proactinomyccs asteroides var crateriformis Baldacci. loc cit.) Less tendency to fragmentation of mycelium Complete lack of aerial mycelium Growing as discrete colonies, disk- or erater-shaped

Nocardia asteroides var (Baldacci) comb. nov. (Proactinomyces asteroides var. decolor Baldacci, loc cit ) Greater tendency to produce white aerial mycelium; vegetative mycelium colorless.

Nocardia asteroides var aunsoides (Baldacci) comb nor (Actinomyces gypsoides Henrici and Gardner, Jour. Inf Dis . 28, 1921, 248, Discomuces gypsoides Brumpt, Précis de Parasitol, Paris, 3rd ed., 1922, 980, Oospora gypsoides Sartory, Champ Paras Homme et Amm , 1923, 802, Proactinomyees asteroides var gypsoides Baldacci, loc cit ) White aerial mycelium; darkening of pentone media

3 Nocardia polychromogenes (Valiće) comb nor. (Streptothrix polychromogenes Vallee, Ann Inst. Past., 17, 1903, 288; Streptothrix plurieromogena Caminiti, Cent f Bakt , I Abt , Orig , 44, 1907, 198; Actinomyces polychromogenes Lieske. Morphol. u. Biol. d. Strahlenpilze, Leipzig, 1921, 32; Proactinomuces poluchromogenes Jensen, Proc. Linnean Soc. New So Wales, 56, 1931, 79 and 363: Oospora polychromogenes Sartory, quoted from Nannizzi, in Pollacei, Tratt. Micopat Umana, 4, 1934, 51; Actinomuces plurichromogenus Dodge, Medieal Mycology, St. Louis, 1935, 737.) From Greek, producing many colors

Description from Jensen (loc. cit.). Long wavy filaments: 0.4 to 0.5 by 70 to 100 microns, extensively hranched but without septa. Older cultures consist entirely of rods 4 to 10 microns, frequently in V, Y, or smaller forms. Still older cultures consist of shorter rods and forms. Gram-positivo, frequently showing bands and granules

Gelatin stab. Thin yellowish growth along the stab with thin radiating filaments Surface growth flat, wrinkled.

red. No linuefaction

Nutrient agar, Seant, orange-red growth.

Glucose agar. After 3 to 4 days raised. flat, glistening, rose-colored growth After I to 3 weeks becoming folded and caral-red

Glucose broth After 3 to 4 days turbid, after 2 to 3 weeks an orange flaky sediment No surface growth.

Milk Growth starts as small orangecolored surface granules After 1 to 2 weeks a thick, soft, orange-colored sediment forms

Optimum temperature 22° to 25°C. Distinctive characters. Differs from Nocardia corallina in the formation of very long filaments and in filiform growth in relatin stalis.

Source. From the blood of a horse; from soil in France and Australia.

Habitat . Soil. 4 Nocardia opaca (den Dooren de

Jong) comb. nov. (Mycobacterium opacum den Dooren de Jong, Cent. f Bakt., Il Abt., 71, 1927, 216; Mycobacterium crus. tallophagum Gray and Thornton, Cept. Description from Erikson (Med. Res. Council Spec. Rept. Ser. 203, 1935, 26).

Initial cells only slightly enlarged; carly development of aerial hyphac, while substratum threads are still short; frequent slipping of branches; seerial mycellum abundant on all media with tendency to form coherent spikes; mycellum not very polymorphous, but occasional thicker segments appear. Slightly acid-fast.

Gelatin: Extensive dull growth with small raised patches of pink serial mycelium; later ribbon-like, depressed. No

liquefaction.

Glucose agar: Irregular bright pink growth tending to be heaped up; later abundant masses frosted over with thin white aerial mycelium.

Glycerol agar Abundant growth, small round pink colonies, partly covered with

white aerial mycelium.

Potato agar · Extensive thin growth, pink in misod patches, covered by white acrial mycelium; later aerial mycelium also becomes pink

Starch agar Minute colorless colonies covered by white aerial mycelium

Blood agar. Minute round coloriess colonies aggregated in broad pink zones, paler aerial mycelium. No hemolysis.

Dorset's egg medium Few colorless colonies, some pink, white aertal mycelium; later, growth becoming dull pink, irregular, with scant white aertal mycelium.

Ca-agar Minute colorless colonies, white aerial mycelium; later a pinkish tinge

Serum agar Small round pink colonies frosted over with thin white serial mycellum

Inspissated serum No growth

Broth Superficial pellicle composed of pink colonies with white aerial mycelium; moderate flocculent sediment

Glucose broth. Small sediment of fine flocculi; later pellicle composed of small pink colonics; superficial skin entire and salmon colored in 16 days Synthetic glycerol solution: Round pink disc-like colonies on surface and tenuous white wispy growth in suspension and sediment; after 20 days, surface colonies bearing white aerial mycelum extending 2 cm up tube.

Synthetic sucross solution: Minute white colonies in suspension and sediment in 3 days; thin dust-like pellicle in 10 days; some surface colonies with white aerial mycelium in 17 days.

Milk: Red surface skin; solid coagulum Litmus milk: Red surface growth, no change in liquid; after 4 weeks, havid decolorized, opaque.

Potato plug: Abundant growth, small colonies, mostly confluent, entirely covered with rele pink aerial mycelium; growth becomes membranous, considerably buckled; later superficial colonies with pink aerial mycelium on liquid at base of tube, bottom growth of round withe colonies.

Starch not hydrolyzed. Source: From lesions in goats.

8. Nocardia pretoriana Pijper and Pullinger. (Pijper and Pullinger, Jour. Trop. Med. Hyg., 90, 1927, 183; Actinomyces preforianus Nannizzi, in Pollacci, Tratt. Micopat. Umana, 4, 1034, 38) Named for Pretoria in South Afrea.

Description from Er.kson (Med. Res. Council Spec. Rept Ser. 203, 1935, 201

Minute flat colonies are formed consisting of angularly branched filaments, and bearing a few short straight serial hyphoc; later the growth becomes spreading and evtensive, the slipping abbanches is well marked and the

Gelatin: A few coloriess manual liquefaction.

Glucose agar: Pale buff umbilicated and piled up colonies.

Glycerol agar: Piled up pink mass, very scant white aerial mycelium at margin Ca-agar: Yellowish wrinkled coherent growth with white aerial mycelium on anices and at markin.

Coon's agar. Colorless mostly submerged growth, scant white aerial myee-

hum
Dorset's egg medium. A few round
colorless colonies in 3 days, after 3 weeks,
irregular mised pink mass, warted appearance, moderate degree of liquefaction.

Serum agar. Raised, convoluted, slightly pinkish growth.

Inspissated serum. No growth

Broth Moderate quantity of flakes and dust-like surface growth

Synthetic sucrose solution A few colorless flakes on the surface, lesser bottom growth

Milk Yellowish surface growth, solid coagulum in one month, later, partly digested, pale pink growth up the wall of the tube

Litmus milk Colorless surface growth, liquid blue, becoming hydrolyzed and decolorized

Potato plug. Small raised pale pink colonies with white aerial myceilum; after 2 months, plug and liquid discolored, growth dull buff, dry and convoluted at base, round and zonate at top of slant, white aerial mycelium, surface and bottom growth on liquid

Source: From a case of mycetoms of the chest wall in a South African native Habitat · Human infections so far as known

9. Nocardia pulmonalis (Burnett) comb nov. (Actinomyces pulmonalis Burnett, Ann. Rept N. Y. State Vet Coll, 1909-1910, 167.) From Latin pulmo, lung

Gram-positive mycelium breaking up readily into oval shaped conider. Acidfast, especially in early stages of growth

Gelatin Small, whitish, apherical colonies, edges of colony becoming chalky white; limited liquefaction Agar: Moist, raised growth in the form of small, apherical colonies

Glucose agar. Dull, whitish, convoluted growth.

Broth: Delicate, translucent film on surface, becoming corrugated with some whitish, spherical colonies in medium. Milk: Colonies on the surface of

Milk: Colonies on the surface of the medium, milk is coagulated in a few days, later digested.

Potato, Lucurant growth in the form of small, translucent, round colonies; becoming colored lemon-yellow; later, growth becomes convoluted or folded with chalky white acral mycelum, color of plug brownish. Non-nathogenic for rabbits and guinea

pigs

Aerobic.

Source From the lungs of a cow Habitat: Bovine infections so far as known.

10. Nocardia paraffinae (Jensen) comb noc. (Proactinomyces paraffinae Jensen, Proc Linn Soc. New So Wales, 56, 1931, 362) From M. L. paroffina, pamffine

In agar media, the organism initially forms an extensive mycelium of long. richly-branching hyphae, 04 to 05 mieron thick After 5 to 6 days, at room temperature, numerous end branches swell to about double thickness, become more refractive, exhibit fine incisions along their external contours, and divide into oval, spore-like elements, 08 to 10 by 1 2 to 1 5 microns This process of division starts at the tips of the swollen branches and proceeds basinetally until most of the hyphac appear divided. Primary septa have not been seen in the hyphae. A similar process of division takes place in liquid media, where also the blaments often fall into fragments of variable length. The spore-like elements, but not the undivided filaments, are markedly acid-fast. The acrual myce. hum consists of rather short, straight, not very much branched hypline, 0.4 to 0 6 micron thick, which never show any differentiation into spores.

Gelatin: No liquefaction.

Sucrose agar: Very scant growth. Thin colorless veil, sometimes with a trace of white aerial mycelium.

Glucose agar: Fair growth. Vegetative mycelium flat, growing into medium; pale ochre-yellow to orange, with raised outgrowths on the surface. Growth of a crumbly consistency. Scant, white, acrial mycelium.

Nutrient agar: Slow but good growth. Vegetative mycelium superficial, somewhat raised, ochre-yellow, hard, but with a loose, smeary surface. Aerial mycelium scant, small white tutts No pigment.

Potato. Fair growth. Vegetative mycellium granulated, first palo-yellow, later deep ochre-yellow to orange. Scant, white, aerial mycelium No pigment

Liquid media (milk, broth, synthetic solutions). Small, round granules of various yellow to orange colors, firm, but can be crushed into a homogeneous smear In old broth cultures a thick, hard, orange to brownish surface pellicle is formed.

Sucrose not inverted Starch not hydrolyzed

Cellulose is not decomposed

Nitrates are not reduced to nitrites. Milk is not congulated or digested.

Final reaction in glucose NH<sub>6</sub>Cl solution, pH 4.6 to 4.4

All strains show a marked power of utilizing paraffin wax as a source of energy. Source: Isolated from soil.

Habitat Soil.

11. Nocardia minima (Jensen) combnos (Proctinomyces minimus Jensen, Proc Linnean Soc New So. Wales, 56, 1921, 365) From Latin minimus, very small

Filaments and rods: 0.4 to 0.6 by 2 to 10 microns In older cultures mostly short rods, frequently V, Y, swollen forms, or cocci. Irregularly stained with ordinary dyes, generally show bars and bands. Generally a few cells from cultures are acid-fast, most are not acidfast. Gram-positive.

Gelatin stab: Filiform, granulated, cream-colored growth. No liquefaction.

Agar: Slow growth, raised, folded, with finely myeloid margins.

finely myeloid margins. At first colorless, after 6 to 8 weeks flesh pink or coral pink.

Potato: Growth slow, after 6 to 8 weeks abundant, spreading, much raised, finely wrinkled, coral pink.

Paraffin is utilized.

Optimum temperature 22° to 23° C. Distinctive characters: Closely resembles Nocardia corallina but thiers in the much slower growth and the smaller size of the cells.

Source: From soil in Australia. Habitat; Soil.

12. Nocardia corallina (Bergey et al.) comb. nov. (Bacillus mycoides corallina Hefferan, Cent. f. Balt., II Abt., II 1904, 459; Serratia corallina Bergey et al., Manual, 1st ed., 1923, 93; Streptohira corallinas Reader, Jour. Path. and Bact. 29, 1926, I; Mycobacterium agreste Gray and Thornton, Cent. f. Bakt., II Abt., 75, 1928, 84; Actinomyces agrestib Ergey et al., Manual, 3rd ed., 1930, 472; Practinomyces agrestis Pensen, Proc. Liancean Soc. New So. Wales, 58, 1931, 315; Proactinomyces corallinus Jensen, tibd., 57, 1932, 364.) From Latin corallinus, coral red.

Description from Gray and Thornton (foc. cit.), Jensen (foc. cit.) and Bynoc (Thesis, McGill University, Montreal, 1931).

Branching rods, generally curved, 1 to 1.5 by 3 to 10 microns. In older cultures generally shorter rods and cocci. Nonmotile. Not acld-fast. Gram-positive.

Gelatin colonies: Round, convex, smooth, pink, shining, edge filamentous Deep colonies: Burrs Gelatin stab: Nailhead; line of atab arborescent. No liquefaction.

Agar colonies: Round, convex, or umbonate, smooth, pink, shining ar matte; border lighter, edge filamentous or with arborescent projections. Deep colonies: Burns, or lens-shaped, with arborescent projections. In their very early stages colonies consist of branching filamentous rods. As the colony grows, the cells in the interior break up into short rods and cocci which eventually form the mass of the colony. Cella on the outside remain filamentous, giving the colony a burrlike appearance, and often forming long arborescent processes.

Agar alant: Filiform, convex, smooth, plnk, shining or matte; arborescent or with projections from undulate border.

Litmus milk: Alkaline. Reddush pel-

Glycerol potato: Filiform, raised, dry, wrinkled, yellowish-brown to coral red

Broth: Usually turbid. Pink soum Dorset's egg medium: Filiform, raised, dry, wrinkled, orange.

Locfler's medium: Similar to growth on Dorset's egg medium, but pink Nitrites produced from nitrates.

Acid from glycerol and glucose with some strains. No acid or gas from auerose, maltese or lactose.

Phenol and m-cresol are utilized Some strains utilize asphthalene. (Gray and Thornton) Some strains utilize phenol or m-cresol (Jensen)

Optimum plI 68 to 80

Optimum temperature 22° to 25°C.

Distinctive characters, Soil organism forming Mycobacterium-like colonies after 2 to 4 days on simple media. Pale pink chromogenesis Nailhead growth in gelatin stab Branching rods and short filaments.

Source · Seventy-four strains isolated from soils in Great Britain and Australia, Habitat · Soil

13 Nocsedia globerula (Gray) comb. nov (Mycobacterium globerulum Gray,

Proc. Roy. Soc. London, B, 102, 1928, 265; Proactinomyces globerulus Reed, in Manual, 5th ed., 1939, 838.) From Latin globus, a aphere.

Description from Gray (loc. cit.) and from Bynoc (Thesis, McGill University, Montreal, 1931).

Curved rods and filaments 1 by 2 to 9 microns, with many coccuid cells, especially in old cultures Rods and filamenta are frequently irregularly swellen. Not acid-fast. Carsules may be present.

Gram-positive.

Gelatin: After 19 days surface colonies irregularly round, 1 to 2 mm in diameter, convex, light buff, smooth, shiming; edge entire. Deep colonies: Round, with entire edge.

Gelatin stab: After 8 days nailhead, irregularly round, convex, pinkish-white, amooth, ahining; line of stab erose.

Agar: After 4 days surface colonies irregularly round, 3 to 5 mm in dismeter, convex, white, smooth, shinling; edge undulate, erose. After 7 days, more convex and of a watery apportance Deep colonies: After 4 days, lens-shaped Agar alant. After 3 days, filtorm, flat.

watery; edge irregular Nutrient and peptone broth; Turbid

with viscous suspension.

Indole not formed.

Litmus milk; Alkaline

Glycerol potato: After 21 hours, filiform, moist, amooth, pale pink.

Dorset's egg medium: After 2 weeks, spreading, raised, moist, orange-colored Loeffler's medium: Growth as on Dorset's egg medium, but salmon-colored.

Nitrites not produced from nitrates.
No acid from glucose, lactose, maltose.

sucrose or glycerol.

Phenol is utilized

Indole agar. Blue crystals of indigotin formed.

Optimum temperature 25° to 28°C.

Optimum pll 6.8 to 7.6. Distinctive characters: This organism

resemblea most closely Nocardia corallina. It is distinguished by pro-

ducing a more natery type of surface growth, more nearly entire deep colonies and more particularly by the production of indigotin from indol.

Source: From soil in Great Britain. Habitat: Presumably soil.

14. Nocardia salmontcolor (den Dooren de Jong) comb. nov. (Algeobacterium salmonicolor den Dooren de Jong, Cent. f. Bakt., II Abt., 71, 1927, 216; Florobacterium salmonicolor Bergey et al., Manual, 3rd ed., 1930, 157; Procetinongers salmonicolor Jensen, Proc. Linnean Soc. New So. Wales, 67, 1932, 363.) From Latin salmo, salmon and color, color.

Closely related to Necardia corallina. On glucose-asparagine-agar after 18 to 24 hrs., long branching rods are formed. 10 to 1.3 microns in thickness, with small refractive granules of aerial mycellum, sometimes stretching into quite long filaments; after 2 to 3 days small definite mycelia are present, and after 5 to 6 days these have largely divided into short rods and cocci; the colonies have the same burr-like appearance as those of Nocardia coralling. Many cells at the edge of the colonies show, after 3 to 4 days, club- or pear-shaped swellings, up to 25 to 30 microns in width; after 5 to 6 days, many of these smollen rells are seen to germinate with the formation of two more slender sprouts (Orskov. Investigations into the Morphology of the ray fung: Copenhagen, 1923, 82, gives an almost identical picture of Streptothers rubra, it is questionable, indeed, whether these two organisms are not really identical )

Gelatin At 20° to 22°C, scant arborescent growth in stab, small wrinkled orange surface colony No liquefaction.

Glucose asparagine agar. Good growth, restricted, rather flat, edges lobate, surface warty, glutening, first pale orange, later ochre-yellow; consistency erumbly After 5 to 6 weeks the growth is paler with many small round raised yellow secondary colonies.

lic

eream-colored, later red; broth clear at first, slightly turbid after 3 neeks

Milk: Good growth; pellicle of small cream-colored granules after 2 days, later a thick orange sediment. Not coaplated, but appears slightly cleared after 5 weeks, the reaction becoming alkaline.

Potato. Good growth, raised, warty, crumbly, glistening, at first buff, charging to orange and finally to slmost bloodred.

Indole not formed.

Nitrites produced from actrates.

Nitrate, ammonium salts, asparagize
and peptone are utilized almost equally
well with glucose as source of carbon,
although the growth is most rapid with

peptone.

Sucrose not inverted, although readily utilized with sodium nitrate as a source

of nitrogen.

Paraffin readily utilized as a source of carbon.

Phenol not utilized. No acid from glucose or glycerol

Starch not hydrolyzed. No grouth in oxygen-free atmosphere Source: Isolated from soil by means of

an ethylamine enriched medium, at 37°C. Habitat: Probably soil.

Nocardia rubropertincta (Hefferan) comb. nov. (Batterbacillus, Grassbarger, Munch. med. Wochnschr., 46, 1899, 343; Bacillus rubropertinctus Heferan, Cent. f. Bahr, II Abt., 11, 1903, 480; Serratia rubropertinctus Bergey et al., Manual, lat ed., 1923, 96; Mycobacterium rubropertinctum Ford, Textb. of Bact., 1927, 255; Proactinomyces rubropertinctus Reed, in Manual, 5th ed.,

1939, 835.) From Latin, colored very red.

Buttner (Arch. Hyg., 37, 1926, 17) regards Mycobacterium os as probably identical with Mycobacterium rubrum Söhngen (Cent. 1. Bakt., 11 Abt., 37, 1913, 599), Grassberger's organism (dec at.), Hormann and Morgentot's organism (Hyg. Rundsch., 7, 1899, 229), and Weber's organism (Arb. a. d. b. Gesund-hettsamte, Berlin, 19, 1930).

To this list Lehmann and Neumann (Bakt. Drig., 7 Auft., 2, 1927, 761) also add the organism of Ascher (Zischr flyg., 32, 1899, 329) and the hutter bacillus of Aujersky (Cent. f. Bakt., I Aht. Orig. 31, 1902, 132)

Jensen (Proc Linnean Soc. New So Wales, 49, 1931, 32) regards the following organisms as probably identical Bacterum rubrum Milgul. (Syst. d. Bakt., 2, 1900, 483) a preliminary description of which is given by Schneider (Arb. bakt Inst. Karlsruhe, I, Heft. 2, 1894, 213); probably this us also the organism referred to by Hang (Cent. f. Bakt., II Akt. 71, 1927, 35) as Bacterum rubrum, and Mycobacterium rubrum Söhngen (loc. etf.)

Description taken from Grassberger (loc. cit.), Hesseran (loc. cit.) and Jensen (loc. cit.).

Small rods. 03 to 09 by 1.5 to 30 microns Cells in 18 to 21 hour agar culture in beautiful angular arrongement. after 2 to 3 days nearly coccoid, 0 6 by 0 S nucron. Tendency for branching on elvectol agar after 2 to 3 days, but branching does not occur commonly though granules of actial mycelium are sometimes seen (Jensen). Not acid-fast (Grass-Acid-fast (Hefferan). Variberger) able (Jensen). Non-motile Grampositive

Gelatin colonies · Irregular with crenate margin and folded surface Corol red

Gelatin stab: Surface growth like the colonies. Growth in stab at first thin, then granular to arborescent with chromogenesis. No liquefaction Agar colonies: Small, granular, becoming pink to red depending on composition of agar.

Agar alant. Dry, lustreless (R) to glistening (S), pink to vermillion red. Broth. Faint uniform turbidity with salmon-pink pellicle (in scales) which is renewed on surface as it settles to forms.

red sediment (Hefferan, Jensen).

Litmus milk: Thick, fragile, dull corol
red surface scales and sediment Unchanged (Hefferan) to alkaline and

changed (Hefferan) to alkeline and somewhat viscid after 3 to 4 weeks (Jensen).

Potato: Slow but excellent intensive

red growth becoming dull orange (Jensen).

Nitrites not produced from nitrates; nitrates, ammonia and asparagine are almost as good sources of nitrogen as peptone (Jensen).

Benzine, petroleum, paraffin oil and paraffin are utilized as sources of energy (Sohngen). No action on manganese dioxide (Sohngen, Cent. f Bakt., II Abt., 40, 1914, 551).

Optimum pll 6 8 to 7 2 Growth stops at pH 4 9.

Temperoture relations Grows well botween 20° and 37°C (Jensen)
Aerobic to facultative anaerobe.

Distinctive characters Mycobacterum-like colonies with coral to vermillion red chromogenesis on asparagine agar, potate, gelatin and other media. Short rods, seldom forms filaments. Generally not acid fast

Source Six cultures isolated from butter (Grassberger) Several cultures isolated from soil in Holland (Söhngen) and Australis (Jensen) Two cultures as contaminents in tuberculin flasks (Hagan, Breed)

Habitat. Probably widely distributed in soil.

16 Notardia rubra (Krassilnikov) comb nor (Pronetinomyces ruber Kras silnikov, Bull Acad Sci U.S.S R., No 1, 1938, 139) From Latin ruber, red Nitrogen is utilized as sodium nitrate, ammonium phosphate and asparagine, although these are inferior to peptone as sources of nitrogen.

Source: Fermented beets.

20. Nocardia flava (Krassilnikov) comb. nov (Proactinomyces flavus Krassilnikov, Bull. Acad. Sci. U. S. S. R., No. 1, 1938, 139.) From Latin flavus, vellow.

Cells at first filamentous, 07 to 0.8 micron in diameter; after 2 to 3 days broken into long rods and then into coci 0.7 micron in diameter. No spores, some strains form chlamydospores. Cell multiplication by fission, cross-wall formation, rarely by budding. Cells Gram-positive; not neid-fast.

Gelatin: No liquefaction.

Synthetic ngar colonies: Bright yellow nr gold color.

Meat peptone media: Dirty yellow pigmentation.

Agar colonies: Pigment bright yellow or gold color on synthetic media, dirty yellow on meat peptone media. Pigment not solublo in medium. Surface of colony somewhat shiny or rough and folded, of n dough-like consistency.

Milk: No peptonization or congulation.

Sucrose weakly inverted.

Starch is hydrolyzed.

Does not grow on paraffin and wax but

makes weak growth on fat. Habitat: Soil, not common.

21. Nocardia viridis (Krassilnikov) comb. nov. (Proactivomyces viridis Krassilnikov, Bull. Acad. Sci. U. S. S. R., No. 1, 1938, 139). From Latin viridis, green.

Mycefual cells often branching, 0.7 to 0.8 micron in dameter with cross-unli; after 5 to 7 days the cells break up into rods 5 to 15 microns long. Cocci not observed. Cells multiply by fasion, seldom by budding. Spores not formed. Cells Gram-positive, not acid-fast

Gelatin: No liquefaction.

Colonies cofored dark green. Pigment not soluble in medium, in water or in organic solvents. Surface of colony somewhat shiny. On potato. rough, much folded, broken up into small colonies.

Milk: No peptonization or congulation Sucrese readily inverted.

Starch weakly hydrolyzed.

Grows well on fats and paraffin and

less on wax. Habitat : Soil.

22. Nocardia citrea (Krassilnikov) comb. nov. (Proactinomyces citres Krassilnikov, Bull. Acad. Sci. U. S. S. R., No. 1, 1938, 139.) From M. L. citreus, lemon yellow.

Mycellum in young cultures consists of very fine threads 0.3 to 0.5 micron in diameter. After several days the cells break up into short rods 0.5 by 1.5 to 5 microns and into cocef 0.3 to 0.5 micron in diameter. Multiplies by fission and bud formation; spores not formed. Cells not neidijsch.

Gelatin: Liquefaction.

Colonies: Yellow-green, usually rough and folded.

Milk: Coagulation and peptonization. Sucrose is inverted.

Starch is hydrolyzed.

Weak growth on fat. No growth on

Habitat: Soil and water.

23. Nocurdia madurae (Vincent)
Blanchard. (Streplothrix mad true Vincent, Ann. Inst. Past., 8, 1894, 139;
Blanchard, Bouchard's Traité de Path
Gén., 2, 1896, 868; Oospora madurae
Lehmann and Neumann, Bakt. Disc.,
1Aul., 2, 1896, 868; Actinomyces madurae
Lachner-Sandoval, Ueber Strahlenpille,
1895, 64; Cladothrix madurae Macé.,
Traité Pratique de Bact., 4th ed., 1901,
1090; Discomyces madurae Gedeelst,
Chaup. Paras. Homme et Animaux.
Paris. 1902, 199.) Named for the discase

Madura foot, with which this organism
is associated.

Oospora unitea Kanthack (Kanthack, Jour Path and Bact, I, 1893, 140; No-cardia unitea Chalmers and Christopherson, Ann. Trop Med. and Parasit., 10, 1916, 23; Discomyees indicest Neveu-Lemaire, Précis de Parasitol Hum, 5th ed., 1921, 42; Actinomyees uniters Brumpt, Précis de Parasitol. Paras, 4th ed., 1927, 1190) is regarded by some authors as identical with Nocardia madurae Blanchard II this is established, then the correct name of the organism is Nocardia unitea (Kanthack) Chalmers and Christopherson

The species described under the name Actinomyces madurae in previous editions of Bergey's Manual is definitely not the true causative agent of the disease and is probably a contaminant carried as a cul-

ture of this species.

Morphology in tissues, growth in form of granules consisting of radiating actinomycosis. In cultures, initial branched mycellium fragmenting into red-shaped and ooccold bodies. No aerial mycelium or spores. Not acid-fast.

Gelatin Growth scant, whitish, no

Gelatin colonies Round, glistening, at first white, then buff to rose or ermson Pigment production is irregular and unpredictable. Occasionally red soluble pigment is produced Growth eventually wrinkled No aerial mycelium

Potato Wrinkled friable growth, buffcolored, sometimes red

Broth Growth as a floccular sediment Milk No change, or slight slow peptonization

Diastatic (?) action

Not pathogenic for the usual laboratory animals, pathogenic for monkeys (Musgrave and Clegg, Philippine Jour Set, Ser B. Med. Sci., 3, 1908, 470).

Habitat Cause of some cases of Madura foot.

24 Nocardla lutea Christopherson and Archibald. (Christopherson and Archibald, Lancet, 2, 1918, 847; Actinomyces Intens Brumpt, Précis de Parasitol., Paris, 4th ed., 1927, 1206) From Latin Intens, yellow.

Description from Erikson (Med. Res. Council Spec. Rept. Ser. 203, 1935, 30).

Initial elements awollen and segmented, giving rise to irregular spreading polymorphous colonies composed of cells of all shapes and sizes with markedly granular contents Later more monomorphous, the filaments being arranged in angular apposition. Sometimes (e.g., on synthetic glycerol agar) the segments are so granular as to appear banded. On potato agar, small filamentous colonies are formed with irregular angular branching and bear a few solated short straight aeral hyphas.

Gelatin · Pale pink wrinkled growth on wall of tube and colorless punctiform and stellate colonies in medium; no liquefaction.

Agar. Abundant, coherent, moist, pink membranous growth with round discrets colonies at margin, after 3 weeks coloriess fringed margin, round confluent portion.

Glucose agar. Scant reddish smeary growth

Glycerol agar: Yellowish-pink, wrinkled membrane

Potato agar Coherent pink moist growth, centrally embedded with small round discrete colonies at margin.

Dorset's egg medium Poor growth, dull pink, spreading.

Serum agar Confluent granular pink membrane Broth Pink flakes and surface growth.

Inspissated serum Raised convoluted pink mass, becoming orange, much wrinkled, scalloped margin.

Synthetic sucrose solution: Red granules and abundant minute colorless colonies at bottom; in 2 weeks a colorless dust-like surface pellicle.

Glucose broth: Abundant, pinkish

flaky surface growth, breaking up easily and sinking to bottom.

Litmus milk: Orange-red surface and bottom growth, liquid blue.

Potato plug. Carrot.red, moist, thick, granular growth in bands, partly mised and with discrete round colonies; sparse colorless very thin aerial mycelium at top of slant in 2 months.

Source: From actinomycosis of the lachrymal gland.

25. Nocardia blackwellii (Erikson) comb. nov. (Actinomyces blackwellii Erikson, Med. Res. Counc. Spec. Rept. Ser. 203, 1935, 37,)

Description from Erikson (loc. cit., p. 32).

Initial elements short, rod-like, growing out into longer forms sparsely branching, small radiating colonies are produced with short straight aerial mycelium. frequently large round or evoid cells are interposed in the irregularly segmented chains of cells, being sometimes isolated in company with 2 or 3 short filaments and sometimes terminal.

Gelatia. Few colorless minute colonics along line of ineculation; after 30 days abundant colorless colonies to 10 mm below surface, larger pink yellow surface colonies with white aerial mycelium; no liquefaction.

Agar: Confluent wrinkled growth with small, round, pinkish, discrete colonies at margin.

de Glucose agar Abundant, pale pink growth, small conical colonies, piled up,

convoluted. Glycerol agar: Extensive, granular, ir-

regular, thin, pinkish growth; after 40 days, a few discrete colonies with depressed margins, center piled up, pink. Serum agar: Smooth, cream, umbilicated colonies, with submerged growth

extending into modium in scallops 5 to 8 mm deep, a pale pink mass in 2 weeks Potato agar. Small, round, colorless

colonies covered with white serial mycelium; after 2 weeks colonies dull pink, submerged margins, few serial spikes, moderate aerial mycelium at top of glant.

Broth: Flakes, later innumerable minute colonies, some adhering to wall just above liquid level.

Synthetic sucrose solution: Delicate, round, white colonies; later abundant minute colonies in suspension, thick cream pellicle on surface and pink grains in acdiment.

Milk: Heavy convoluted bright yellow surface pellicle, no congulation.

Litmus milk: Yellow surface growth. milky sediment, liquid unchanged.

Carrot plug: Small, round, smooth, cream-colored elevated colonies in 10 days; sparso stiff colorless aerial spikes in 16 days; abundantly piled up, convoluted, ochreous growth in 25 days.

Source: From hock joint of foal.

26. Nocardia lluolaup Spijders. (Snijders, Geneesk. Tijdsch. Med. Ind., 64, 1924, 47 and 75; Actinomyces cuniculi Drikson, Med. Res. Council Spec Rept. Ser. 203, 1035, 32; not Aclinomyces cuniculi Gasperini, Cent. f. Bakt , 16, 1894, 684; Actinomyces sumatrae Erikson, loc. cit., 32.) From Latin cuniculus, rabbit.

Description taken from Erikson floc.

cit., p. 31). Large swollen cells give rise to ramify. ing filaments or to small chains of short thick segments which branch out into more regular hyphre; sometimes the irregular elements are beset with spiny processes before giving rise to typical long branching filaments; later the picture becomes more monomorphous and short straight nerial hyphae are borne, which presently exhibit irregular segmentation.

Gelatin: Few flakes. No liquefaction. Agar: Small, round, elevated, creamcolored colonies, umbilicated and radially wrankled.

Glucose agar · Minute, colorless colon-

ies; becoming dull pink, partly confluent and piled up, few stiff pink acrial spikes.

Glycerol agar: Small round clevated cream-colored colonies, margins depressed; becoming smooth, discrete, vellowish.

Dorset's egg medium, Scant pinkish smeary growth.

Serum agar: Small, raised, creamcolored colonies, becoming confluent and piled up

Inspissated serum, Thick, colorless, ribbed membrane; no liquefaction Broth, Small and larger ercam-colored,

scale-like surface colonies, abundant, floceulent bottom growth.

Synthetic sucrose solution; Thin surface pellicle, small colorless finkes, minute particles at bottom, scant growth Milk · Heavy yellow growth attached to

walls; solid cosgulum in 1 montb

Litmus milk. Yellow surface growth, hould unchanged.

Potato plug. Coral-plnk, dry, granular growth, covered to a considerable extent with white aerial mycelium, piled up in center, discrete colonies at margin, pink surface pellicle on liquid and colorless colonies at base

Source: Infected rabbits.

27 Nocardia rangoonensis (Crikson) comb nov. (Actinomyces rangoon Erskson, Med. Res Council Spec Rept Ser. 203, 1935, 37 )

Description from Erikson (loc. cit. p. 33)

Swollen round mitial cells, giving rese to branching hyphac which segment and present alipping and angular arrangement; few short straight aerial hyphae. which later develop into a profusely branching long waving serial myechum. Non-neid fast.

Gelstin Abundant minute colonies in depths and larger cream-colored ones on surface with white acrid mycelium; brown pigment surrounding growth No liquefaction.

Agar colonies: Round, lobate, umbili-

cated, raised up, cream-colored to pale pink; later, raedium discolored dark brown, colonies colorless.

Glucose agar: Convoluted, coherent, cream-colored growth, medium discolored After 23 days, wrinkled, biscuit-colored growth, colorless margin, border white aerual mycelium, medium

dark brown. Glyccrol agar. Dull, mesly, pink, wrinkled growth, scant white serial mycelium at top, medium slightly discolored.

Coon's agar: Minute colorless colonies in streaks.

Potato agar: Small, round, lemoncolored colonies, partly confluent, with white acrisl mycolium, later medium dis-

colored light brown, submerged growth greenish. Dorset's egg medium : Extensive color-

less growth, pale pink acrial mycelium in center, later covered with a powdery pinkish-white acrial mycelium, Serum agar colonies Irregular, small,

elevated, cream-colored, frequently umbilicated. Inspissated serum Poor growth, small

piled up pink mass. Abundant colorless growth,

flocculent mass at bottom and pellicle at surface, medium slightly discolored.

Synthetic sucrose solution Small white colonics with ninkish tinge on surface. lesser bottom growth.

Milk Congulation, yellow surface ring. becoming partly pentonized, liquid discolored dark brown, brownish growth up side of tube.

Litmus milk Colorless growth, liquid partly decolorized; congulation; later partly digested.

Carrot plug Small round colorless colonies, velvety white aerial mycchum; in 2 months, piled up pink granular mass with warted prominences, marriaal zone white serial mycelium and thin all over central acrial mycelium.

Source: Iluman pulmonary case of streptothricosis.

Habitat: Human infections so far as known:

28. Nocardia eavise Snijders. (Snidjers, Geneesk. Tijdschr. Ned. Ind., 64, 1923, 47 and 75; Actinomyces calic Erikson, Med. Res. Council Spec. Rept. Ser. 203, 1935, 37.) From the generic name of the guines pig.

Description from Erikson (loc. cit.,

p 02)

Initial segmentation, producing elements of approximately even thickness arranged in sugular apposition, and later long profusely ramifying threads with strongly refractile protoplasm. Aerial raycelium straight and branching, the aerial hyphae with occasional colled tips divided into cylindrical conidis.

Gelatin: A few colorless flakes. No

liquefaction.

Glucose agar: Piled up, convoluted, cream-colored to pale pink growth, white aerial mycelium.

Glycerol agar: Scanty growth,

Coon's agar: Colorless scant growth, partly submerged, white serial mycelium. Potato agar: Colorless spreading growth

with dense white aerial mycelium.

Dorset's egg medium: Heavily corru-

gated pale pink growth with submerged margin, dense white aerial mycelium la center; after 3 weeks, colorless transpired drops. Serum agar: Pale pink wrinkled

Serum agar: Psie pink whiteled growth, partly submerged; after 4 weeks, piled up with scant white aerial mycelium, medium discolored reddish-brown.

Inspissated serum: Pale pink raised growth, coiled, white aerial mycelium. Broth: Cream-colored wrinkled surface

pellicle extending up wall and breaking easily, moderate bottom growth, flaky, medium discolored Synthetic sucrose solution: Round

white colonies in suspension and attached to one side of tube, pink surface colonies with white aerial mycelium.

Milk: Colorless surface growth, white aerial mycelium; coagulation Litmus milk: Liquid blue, surface growth; after 1 month, white aerial mycelium, colorless sediment, liquid still blue.

Potato plug: Small colorless colonies, white powdery aerial mycelium; later abundant raised pate pink confluent growth, discolored plug; after 2 months, raised buckled pink colonies with white aerial mycelium floating on liquid at base. Source: Infected guines pigs, Sumata.

29. Nocardia actinomorpha (Gray and Thornton) comb. nov. (Mycobacterium actinomorphum Gray and Thornton, Cent. f. Bakt., 11 Abt., 73, 1923, 85; Atinomyces actinomorphus Bergey et al., Manual, 3rd ed., 1930, 471; Practino-

ahape, form.

Description from Gray and Thornton (loc. cst.), Jensen (loc. cst.), and Bynoe (Thesis, McGill University, Montreal, 1931).

Long branching filaments and rods: 05 to 0.8 by up to 10 microns. In older cultures rods 2 to 3 microns long generally predominate. On some media extentively branching hyphas occur. Readily strained. Not acid-fast. Gram-positive

Gelatin colonies: After 12 days, round, saucer-like, white, raised run, edges burred. Liquefaction. Deep colonies: Burrs.

Gelatin stab: After 8 to 14 days, saccate liquefaction, 5 to 8 mm.

Agar colonies: Alter 11 days, round, I mm in dameter, convex, white, granular or resinous; long arborrescent processes from the edge. Deep colonies: Arborescent burrs; processes about equal to diameter of colony.

Agar slant: Filiform, mised to convex, white, rugose, dull; edge undulate, with strong tufted projections below surface.

Broth Turbid, or clear with white soum

Dorset's egg medium: After 2 weeks, raised dry, smooth, salmon-huff growth.

Loefller's medium: After 2 days, smooth, moist, warty, salmon-colored growth.

Litmus milk: Alkaline after 5 to 7 days. Glycerol potato: After 2 days, dry, wrinkled, pink to orange growth.

Natrites are produced from nitrates.

No acid from glucose, lactose, sucrose
or glycetol.

Phenol and asphthalene are utilized Optimum temperature 25° to 30°C.

Optimum pH 7 8 to 8 5.
Distinctive characters: Differs from Nocardia coelioca in saccate liquefaction of relatin. Long rods and filaments.

Source: A few strains have been isolated from soil in Great Britain and Australia

Habitat : Presumably soil.

30. Nocardia flavesceus (Jensen) comb nov. (Proactinomyces flavescens Jensen, Proc. Linnean Soc. New So Wales, 56, 1931, 361.) From Latin flavescens, becoming golden yellow.

On media where a firm growth is produced, the vegetative mycelium appears as long, branched, non-septate hyphae, 0 4 to 0 6 micron thick. In other media. as on nutrient agar and potato, septa are formed and the mycelium appears in preparations as fragments of very variable size, partly resembling highly branched mycobacteria. In several eases-for instance, on nutrient agar at 28° to 30°C, in 5 to 6 weeks old cultures in glucose broth, and in glucose NIL Cl solution-short clements assume swollen. fusiform to lemon-shaped forms. The aerial mycelium consists of fairly long hyphae of the same thickness as the vegetative hyphre, not very much branched, without spirals, often clinging together in wispe. A differentiation into spores is never visible by direct microscopic examination. Neither is this the case in stained preparations; here the aerial hyphae break up into fragments of quite variable length, from 1.2 to 1.5 up to 10 to 12 microns, showing an irregular, granulated staining

Gelatin: Slow liquefaction.

Sucrose agar; Good growth. Vegetative mycelium superficially spreading, much raised and wrinkled, cracking, white to cream-colored, of a dry, but loose and crumbly, consistency. Aerial mycelium scant, thin, white. Faint yellow subble nigment after 2 to 3 weeks

Glucose agar: Good growth Vegetative mycelium superficial, wrinkled, honey-yellow, of a hard and cartilaginous consistency Aerial mycelium thin, amooth, white. Yellow soluble nigment.

Nutrient agar: Good growth. Vegetative my celium raised and much wrinkled, first dirty eream-colored, later dark yellon ish-gray, of a soft, moist, curd-like consistency. No serial mycelium. No nigment.

Potato: Good to excellent growth. Vegetative mycelium much raised and wrinkled, first cream-colored, later yellowish-hrown, soft and smeary. No serial mycelium, no pigment.

Glucose broth Rather scant growth. Granulated, yellowish sediment; no surface growth. Broth clear No pigment. No scidity.

Sucroso is inverted.

Starch is hydrolyzed.

Cellulose is not decompraed.

Number are reduced slightly or not at

all with various sources of energy.

Milk: Congulated and alonly redu-

Milk: Congulated and alonly redissolved with acid reaction.

Final reaction in glucose-NH<sub>4</sub>Cl solution, pH 3 9 to 3.6.

No growth under anaerobic conditions. Habitat. Soil.

31. Nocardia maculata (Millard and Burr) comb. nor. (Actinomyces maculatus Millard and Burr, Ann. Appl. Bul., 15, 1929, 559; Proactinomyces maculatus Umbreit, Jour. Bact., 33, 1939, 81.) From Latin maculatus, spotted.

Description taken from Umbreit.

Filamentous organisms possessing a tough shiny colony which is cartilaginous, rarely producing an aerial mycelium, though in certain strains, it may occur frequently. Retains the mycelium form for long periods. Not acid-fast.

Gelatin : Liquefaction.

In the young colony an orange-yellow to orange-red intercellular pigment is produced on all media, which may or may not change to black as the culture ages.

Milk: No digestion.
Starch is hydrolyzed.
Does not utilize paraffin.
Habitat: Soil.

Nocardia rhodnii (Erikson) comb.
 nor. (Actinamyces rhodnii Erikson,
 Med. Res. Council Spec. Rept. Ser.
 203, 1935, 37.) Named for the insect genus, Rhodnius.

Description from Erikson (loc. cit., p 29).

In early stages, the minute colonies are composed of hyphal segments arranged in angular apposition; the acrial mycelium being short and straight. Later the growth becomes extensive and spreading, made up partly of long, genuinely branching filaments and partly of abort segments evhibiting slipping branching, each giving six to acrial hyphae. After 2 weeks the angular branching is very marked, delicate spreading herring-bone patterns being formed.

Gelatin · Rapid liquefaction; pale pink colonies in superficial pelliele and sediment.

Coon's agar. Colorless pinpoint colonies.

Czapek's agar Minute, colorless, round

colonies.

Glucose agar · Abundant, comi pink, convoluted, piled up growth

Clycerol agar Extensive growth, dull pink colonies round and umbilicated, becoming piled up and deeper coral, later partly submerged Dorset's egg medium: Salmon-pink, granular membrane; later piled up.

Serum agar: Extensive, reddish, confluent mass, granular, tending to be piled up; the medium around the growth shows reddish coloration in 2 weeks.

Inspissated serum: Smooth, round, pale pink colonies, centrally depressed and irregularly coiled larger mass; no liquefaction.

Broth: Salmon-pink flakes in sediment and colonies on surface; after 2 weeks abundant growth, discoloration of medium.

Glucose broth: Thin, pink, superficial pellicle, easily breaking up, and small flakes in sediment; after 2 weeks abundant growth extending up tube.

Synthetic sucrose solution: Colorless to pink colonies in superficial pellule, and minute round white colonies coherent in loosely branching mass in sediment.

Milk: Bright orange growth; medium unchanged.

Potato agar. Abundant, pink growth, piled up, scant still white aerial mycelium at top of slant.

lium at top of slant.

Source: From reduvid bug, Rhodnius profesus.

33. Notardia gardneri (Washman) comb. nov. (Actinomycete, Gardner and Chain, Brit. Jour. Exp. Path., 23, 1912. 123; Proactinomyces gardneri Washman, in Washman, Horning, Welsch and Woodruff, Soil Sci., 24, 1942, 289). Named for Prof. Gardner who first isolated this ornanism.

Gram-positive, branching mycelium.
Gelatin: Cream-colored surface ring

Rapid liquefaction. Creen to greenishbrown soluble pigment gradually diffuses through the liquefied portion.

Nutrient agar Cream-colored, elevated, lichenoid growth, soft, not leathery; no aerial mycelium; very faint browpish pigment.

Glucose agar: Brownish, lichenoid

growth, with wide, cream-colored edge; white to grayish aerial mycelium gradually covering surface Reverse of growth

yellowish; no soluble pigment. Glucose-asparagine agar · Aerial myce-

Tryptone broth Growth occurs as small pellets at the base of the flask; later, a thin surface pellicle appears, which consists of a branching mycelum Black pigment slowly produced

Litmus milk: Unchanged.

Potato Barnacle-like, brownish, spreading growth, no acrual mycelium Medium brownish around growth.

Indole not formed.

hum develops slowly.

No acid from glucose, lactose, maltose, mannitol, aucrose and dulcitol.

Good growth at 25°C. Slow growth at 37°C

Distinctive character. Produces an antibiotic substance (proactinomycin) upon synthetic and organic media which is primarily active against various Grampositive bacteria.

Source: Isolated as an air contaminant at Oxford, England.

 Appendix I: The following species probably belong to this genus. Many are incompletely described. Some of the species lated here may belong in the genus Sireptomyces.

Actinomyces albus acidus Neukirch, (Neukirch, Inaug Dies, Strassburg, 1902, 50, Actinomyces albus var airdus Nannizzi, in Poliacci, Tratt Micopat Umana, 4, 1931, 9.) From a case of kerattis.

Actinomyers awadi Dodge (Streptothrix madurae Koeli and Stutzger, Zischr (Hyg., 69, 1911, 17; not Streptothrix madurae Vincent, Ann Inst. Past, 8, 1891, 129; Dodge, Medical Mycology, St. Louis, 1935, 729.) From a Madura foot in Egypt, case of Dr. Avad.

Actinomyces bolognesii-chiureoi (Vinilemin) Dedge (Malbrachea bolognesi and Chiureo, Vinilemin, in Bolognesi and Chiureo, Archivi di Biol. 1, 1925; Dodge, Medical Mycology, St. Louis, 1935, 766) From ulcers on the thorax.

Actinomyces cameli (Mason) Sartory and Bailly (Streptotheric cameli Mason, Jour Trop, Med and Theran, 33, 1919, 34, Oospora cameli Sartory, Champ Paras Homme et Anim, 1923, 822, Sartory and Bailly, Myeoses Pulmonaires, 1923, 233) From pseudotuberculosis lessons in a cancil

Actinomyces canis (Rabe) Gasperini (Discounces pleuritieus Vachetta. Studi e ricordi clin Milano, 1882, Pleuromyces canis familiaris Rivolta, Giornali d Anat Fisiol, a Patol, 16, 1884, 4: Cladothrix canis Rabe, Berlin tierarzti. Wochnschr , 1888, 65, Gasperini, Ann Ist. d'Ig sper Univ Roma, 2, 1892, 222, Streptothrix canis and Actinomices pleuritieus canis familiaris, quoted from Gasperini, Cent f Balt, 15, 1894. 681, Leptothriz plcuriticus Piana and Galli-Vallerio, 1896, quoted from Nannizzi, in Pollacci, Tratt. Miconat. Umana, 4, 1931, 37, Nocardia canis Chalmers and Christopherson, Ann Trop Med and Parasit , 10, 1916, 255, Oospora cants Sartory, Champ Paras. Homme et Anini , 1923, 821 ) Rabe isolated this organism in two cases of phlermen and a case of peritonitis in dogs,

Actnomyces cultoreneus Nannzzi (Mycobacterium diphtheriac acium Trincas, 1907, quoted from Nannzzi, in Pollacci, Tratt Micopat. Umana, 4, 1934,50, Nannizzi, idem.) From a disease in lirids

Actinomyces dassonriller Brocq-Roussen (Brocq-Roussen, Thèse Sci

<sup>\*</sup>The appendix was originally prepared by Prof. S. A. Walsman and Prof. A. T. Henner, May, 1913; it has been developed further by Mrs. Eleanore Heist Clive, Geneva, New York, August, 1915.

Nat. Paris, 1907; Nocardia dassonrillei Liégard and Landrieu, Ann. d'Occulistic que, 46, 1911, 418; Disconyect dassonrillei Brumpt, Précis de Parasitologie, Paris, 2ud ed., 1913, 976) Reported from a case cervical absects (Brumpt), from a case of conjunctivitis (Liégard and Landrieu), and from grain (Pinoy, Bull. Inst. Past., 11, 1913, 923).

Actinomyces dermatonomus Over. (Bull. Austral. Jour. Exp. Biol. Med. Sci., 6, 1929, 301, quoted from Dodgo, Medical Mycology, St. Louis, 1935, 719; Over, 1930, quoted from Nannizzi, in Pollacci, Tratt. Micopat. Umana, 4, 1931, 51.) From lesions on ebeen in Australia.

Actinomyces donnae Dodge. (Streptothriz sp. Donna, Ann. Ig. Sperim., 14, 1904, 449; Dodge, Medical Mycology, St. Louis, 1935, 745.) From sputum in a pulmonary infection.

Actinomyces dori (Beurmann and Gougerot) Brumpt. (Spnotfischum, Dor, Prasse Méd. 14, 1903, 231; Spnotfischum, dori Beurmann and Gougerot, Ann. Derm Syphiligr. IV, 7, 1906, 996; Discomyces dori Beurmann and Gougerot, Les Nouvelles Mycoses, 1909, 59; Rhinocladium dori Navou-Lemaire, Précis Parasitol., 1821, 45; Goapora dori Sartory, Champ. Paras. Homme et Anim., 1923, 770; Brumpt, Précis de Parasitol., 416, 1927, 1905; Nacarda dori Vuillemin, Encyclopédie Mycologique, Paris, 2, 1931, 231.) Found in subcutaneous absesses resembling sportriclosis.

Actinomyces hommis Berestheff. (Berestneff, Inaug. Diss., Moskow, 1897; not Actinomyces hommis Wakaman, Soil Science, 8, 1919, 129; Nocardia hominis Chalmers and Christopherson, Ann. Trop Med and Parasit., 10, 1916; Discomyces hommis Brunpt. Précis de Parasitol, Paris. 3rd ed. 1922, 984.) From a case of pseudoactinomycosis.

Actinomyces japonicus Cammti. (Strepiothrix sp. Aoyama and Miramoto, Mitteil Med Fak K Jap Umv Tolia, 4, 1901, 231; abst. in Cent. f. Bakt., I Abt, Orig., £9, 1901, 202; Caminit, Cent. f. Bakt., I Abt., Orig., £4, 1907, 1985; Streptathir: apponica Petruschly, in Kolle and Wasserman, Handb. d path. Mikroorg, 2 Aufl., £, 1913, 205; Discomptee apponicus Brumpt, Precis de Parasitol., Paris, 3rd ed, 1922, \$81) From a case of actinomycosis of the funcs.

Actinomyces Leratolytica Acton and McGuire. (Indian Med Gar, 65, 1930, 61 and 66, 1931, C5; Proactinomyces Leratolyticus, author unknown.) Produces cracked heels among the ryots of India.

Actinomyces lepromatis de Souz-Araujo. (Compt. rend. Soe Biol., 100, 1929, 987.) From a leproms, Brazil. Actinomyces levyi Dodge. (Actinomyces sp. Levy; Oospora sp. Sartory, Champ. Paras. Homme et Anim., 1923, 827; Dodge, Medical Mycology, 55 Louis,

1935, 730.) From pus.

Actinomyces micetomae Greco.
(Streptolin:s micetomae argentines f.
Greco, in Durante, Segunda Observación
de Pié do Madura o Micetoma en la Repóblica Argentina, Thesis, Buanes Aires,
1911; Greco, Origina des Tuneurs, 1916,
720. Osepera micetomae Sartory, ChampParas, Homme et Anim., 1923, 731

From a case of mycetoma pedia.

Actinomyces reintmus (LeCaive and
Malberbe) Dodge (Oaspora forme de
Microsporum (At aviini var. equium),
Bodin, Arch. de . arasitol., 2, 1839, 606;
Tuchophqutan m nimum LeCaive and
Malberbe, Arch. de Parasitol.; Microsporum ministem Castellani and
Calmers, Mar Trop. Med., 3rd ed,
1919, 993; Dodge, Medical Mycology, 8t
Louis, 1935, '23.) From ringworm of
horse and dog.

Actinompe : mucosus Basu (Indian Med Gar. 78, 1943, 577.) From brouchial actinomycosis.

Actinom es neddeni Namyslowski. (Streptoti ex sp. zur Nedden, Klin Monstsbi. f. Augenheilk., 45, 1907, 152; Nan yslowski, Cent. f. Bakt., I Abt., Orig., 62, 1912, 564.) From a case of keratitis.

Actinomyces nodosus (Beveridge) Hagan. (Fusi/ormis nodosus Beveridge, Austral. Council Sci. and Indua. Res. Bul 140, 1941, 55 pp; Hagan, The Inlectious Diseases of Domestic Aumals. Ithaca, New York, 1913, 312.) Considered the primary cause of foot-rot of sheep. Also see Spirochacta penorita.

Actnomyces phenotokrans Werkman. (In Gammel, Arch. Derm. Syphilol., 29, 1931, 235.) From granuloma in man. Actnomyces puntonii López. Ortuga (López Ortuga, Antala d'Igiene, Rome, 44, 1931, 867; Asteroides puntonii Puntoni and Leonardi, Boll. e Atti d R. Acead. Med di Roma, 61, 1935, 91.) From a pulmonary abscess

Actinomyces purpureus Cavara. (Orloff, Vestnik Ofth., 29, 1912, 653, Cavara, Micosi Occ., 1928, 99, not Actinomyces purpureus Killian and Fehér, Ann. Inst. Past., 65, 1935, 620) From a case of keratilis in Russis.

Actinomyces ribeyro Dodgo (Hongo artrosporado Ribeyro, Ann. Fae. Med. Lura, 3, 1919, 1; Dodge, Medical Mycology, St. Louis, 1935, 735) From a generalized infection on the arms, legs and chest of a patient in Peru.

Actinomyces rodellae Dodge. (Streptothrix sp. Rodella, Cent. f. Bakt., I. Abt., Orig., 84, 1920, 450, Dodge, Medical Mycology, St. Louis, 1935, 731.) From abscesses of the tooth and jaw

Actinomyces ruber (Kruse) Sanfelice (Un Clauktriz cromogene, Ruiz Casabé, Cronica medico-quirurgica de la Habana, 29, No. 13, 1891, 310, see Cent. f. Bakt, 1 Abt. 17, 1895, 466; Strepthriz rubra Kruse, in Flugge, Die Mikroorganismen, 3 Aufl. 2, 1896, 63, Claudthriz rubra Macé, Traité Pratique de Bact., 4th ed. 1931, 1937, not Actinomyces ruber Kransky, Cent. f. Bakt., II Abt. 44, 1911, 652; Sanfelice, Cent. f. Bakt., II Abt. 44, 1911, 652; Sanfelice, Cent. f. Bakt., II Abt. 47, 1914, 652; Sanfelice, Cent. f. Bakt., II Abt. 47, 1914, 652; Sanfelice, Cent. f. Bakt., II Abt. 47, 1914, 652; Sanfelice, Cent. f. Bakt., II Abt. 67, 1914, 263, 1991, 355; Nocardia rubra Chalmers and Christopherson, Ann. Trop Med. and Parasit., 16, 1916, 263.

Discompces ruber Brumpt, Précis de Parasitol., Parıs, 3rd ed., 1922, 931.) From sputum Some authors consider the following synonymous with this organism: Streptothriz mineacea (Actinomyces mineaceus Lachner-Sandoval, Ueber Strahenpilze. 1998, 66).

Actinomyces rubidaurcus Lachner-Sandoval. (Cladothrix mordoré, Thirv. Arch. Physiol. Norm. et Path., 9, 1897, 283; Lachner-Sandoval, Ueber Strahfenpilze, Inaug Diss , Strassburg, 1898, 66, Actinomyces mordoré, Thiry, Thèse, Nancy, 1900, 82, Nocardia mordoré, Chalmers and Christopherson, Ann. Trop Med. and Parasit., 10, 1916, 265; Nocardia thiryes de Mello and Pais, Arq. Hig. Pat. Exot , 6, 1918, 193; Discompces thiry: Brumpt, Précis de Para sitol , Paris, 3rd ed , 1922, 981; Oospora mordoré, Sartory, Champ. Paras Homme et Anim , 1923, 824; Actinomyces thiry: Sartory and Bailly, Mycoses Pulmonaires, 1923, 252) From a case showing anginous evudate with edema

Actinomyces salvati Langeron. (Langeron, Bull. Soc Path. Evot., 15, 1922, 526; Fontoynont and Salvat, 151d., 596.) From generalized nodular lesions in the Madagascar rat.

Actinomyces sartory: Dodge. (Oospora pulmoalis var. acido-resistant, Sartory, Arch. Med. Pharm Milit., 70, 1016, 603; Dodge, Medical Mycology, St. Louis, 1933, 756) From a putient showing symptoms of pulmonary tuberculosis

Actinomyces septicus Mac Neal and Blevins. (Jour. Bact., 49, 1945, 605.) From human endocarditis

Actnomyces serratus Dodge. (Actinomyces asteroides var. serratus Sartory, Meyer and Meyer, Ann. Inst. Past., 44, 1930, 293; also see Compt. rend. Acad. Sci. Paris, 185, 1929, 745; Dodge, Medical Mycology, St. Louis, 1935, 745) From a case of actinomycosis of bones with yellow grains.

Actinomyces sommeri Greco. (Streptothrix madurae Greco, Primer Caso de Pié de Madura o Micetoma en la República Argentina, Thesis, Buenos Aires, 1901; Streptothriz micetomas argentinae a, Greco, in Durante, Segunda Observación de Pié de Madura o Micetoma en la República Argentina, Thesis, Buenos Aires, 1911; Greco, Origina des Tumeurs, 1916, 726; Nocardía micetoma-cargentinae Durant, 1911, quoted from Brumpt, Précis de Parasitol., Paris, 3rd ed., 1922, 985; Gospora commeri Sartory, Champ. Paras. Homme et Anim., 1923, 783.) From a case of mycetoma pedia in Argentina.

Actinomyces tossicus Dodge. (Actinomyces albus var. tossica Rossi, Ann. Ig. Sperim. 9, 1905, 693; Osspora alba var. toxique, Sartory, Champ. Paras Homme et Anım, 1923, 829; Dodge, Medical Mycology, St. Louis, 1935, 719) From tumors in the abdominal cavities of domestic four.

Actinomyces prethridis Brumpt. (Précis do Parasitol., Paris, 4th ed., 1927, 1203.) Isolated by Roček in 1920 from cases of prostatitis

Actinomyces variabilis Colin (Cent. f. Bakt., I Abt., Orig., 70, 1913, 301.) From pus in the bladder in a case of cystitis and from the prostate.

Asteroides pseudocarneus Puntoni and Leonardi. (Boll e Atti d R. Accad Med. di Roma, 61, 1935, 93.)

Bacillus beresinews Lepeschkin. (Cent. f. Bakt., II Abt., 12, 1904, 641 and 13, 1904, 13) From sputum of a pneumonia patient.

Bacillus (Microcaccus?) havaniensis Sternberg, Manuslo Bact., 1893, 718; Bacterium havaniensis Chester, Ann Rept Del Col Agr Exp Sta., 9, 1897, 116; Serratia havaniensis Bergey et al., Manual, 1st ed., 1923, 95) From human intestinal canai

Cladothriz matruchot: Meudel. (Mendel, Compt. rend. Soc. Biol. 82, 1919. 583; Nocardia matruchoti Pettit, 1921, quoted from Nannizzi, in Pollacci, Tratt. Micopat. Umana, 4, 1934, 51; Oospora matruchoti, quoted from Nannizzi, idem; Actinomyces matruchoti Nannizzi, idem) From the roots of a decaying tooth with tumefaction. Spenes dubia.

Cohnistrepothrix misri Carpano (Riv. di Parassitologia, n 2, p. 197; quoted from Boll. d. Sez. Ital. d. Sec. Ital. d. Sec. Internat. d. Microbiol, 10, 1938, 62) From human dermatosis in Egypt.

Discompees berardinisi Brumpt, (Strephothriz sp. de Berardinis, Ann Ottalmol. Lawori Clin. Oculist. Napol., 53, 1901, 914; Actinomyces de Berardinis, Namyslowski, Cent. f. Bakt., I Abt, Orig., 62, 1912, 580; Brumpt, Piecis de Parasitol., Paris, 3rd ed., 1922, 977: Actinomyces bernardinisi Brumpt, 1867; 4th ed., 1927, 1189; Nocardia berarinus Vuillendin, Encyclopédie Mycologique, Paris, 2, 1931, 128.) From a case of keratitis.

Discomyces brasiliensis Lindonberg (Lindenberg, Rov. med. de 8 Peolo, 1909, No. 18, and Arch. de Parasido, 13, 1909, 265; Nocardas brasilirais Pinoy, Bull. Inst. Past., Paris, II, 1913, 396; Streptothriz brasiliensus Greco, Origine des Tumeura, 1916, 724; Oaspon brasiliensis Gomes, Ann Palistas Med Crurgs, 14, 1923, 150.) From a case of mycetoma of the leg. According 19 Punoy and others, idential with Nocardia asteroides.

Discomyces congolensis Baerts (Baerts, Bull. Méd. Katanga, 2, 1925, 67, Adv nomyces congolensis Brumpt, Prétis de Parasitol., Paris, 4th ed., 1927, 1926) From tesions in a case of actionnycess from the Belgian Congo.

Discomyces dispar (Vidal) Brumpt Alterosporon dispar Vidal, 1882, Mersporon acmeon Vidal, 1882 and Sportrichum dispar, quoted from Brumpt, Prócis de Parasitol, Paris, 3rd ed., 1923 955 and from Nannizzi, in Polista, Tratt. Micopat. Umana, 4, 1934, 23, Brumpt, 1dem; Actinomyces diper Brumpt, 1862, 4th ed., 1927, 1298) From a case of pityriasis Species dubia

Discompees mexicanus Boyd and Crutchfield. (Boyd and Crutchfield, Amer Jour Trop. Med, 1, 1921, 268, Actinomyces mexicanus Brumpt, Précis de Parasitol, Paris, 4th ed. 1927, 1192; Nocardia mexicana Ota, Jap Jour Derm. 15rol, 28, 1923.) From a mycetoma of the Ioot.

Discomyces minutissimus (Burchardt) Brumpt (Microsporon minutesimum Burchardt, in Uhle and Wagn Pat Gen . 1859; Trichothecium sp J. Neumann, 1868, Microsporon gracile Balzer, Ann. Derm Syphiligr., II, 4, 1893, 681; Sporotrichum minutissimum Saccardo, Sviloge Fungorum, 4, 1886, 100, Microsporoides minutissimus Nevcu-Lemaire, Précis Parasitol , 1906, Brumpt, Précis de Parasitol , 1st ed., 1910, 863; Oospora minutissima Ridet, Oospora et Oosporoses, 1911, 68; Nocardia minutissima Verdun, Précis parasitol., 1912; Actinomuces minutissimus Brumpt, abid . 4th ed , 1927, 1199 ) Reported as the etiological agent of erythrasma

Mycobactersum alluriolum Bergey et al (Kersten, Cent. f Bakt., I Aht., Orig., 61, 1909, 494; Bergey et al., Manual, 1st ed., 1923, 379) From soil

Mycobacterium consolutum Gray and Thornton (Gray and Thornton, Cent f Bakt, 11 Abt, 73, 1928, 87; Actnomyces consolutus Bergey et al., Manual, 3rd ed., 1930, 473.) From soil. Resembles Nocarda opaca.

Nocardia arborescens (Edington) Trevisan. (Bacillus arborescens Edington, Brit Med. Jour, June 11, 1887, 1262, Trevisan, I generic le specie delle Battenrace, 1889, 92; detinomyces orborscens Gasperini, Cent. f. Bakt., 16, 1891, 684) From human skin in cases of scataltina.

Nocardia bahiensis da Silva (Da Silva, Brasil Med , 55, 1919, 81 and Mem. Inst Butantan, 1, 1918-1919, 187, Discompetes bahiensis Neveu-Lemaire, Précis de Parasitol. Hum., 5th ed., 1821, 44, Oospora bahiensis Sartory, Champ. Paras. Homme et Anim., 1923, 784; Actinomyces bahiensis Brumpt, Précis de Parasitol., 4th ed., 1927, 1195.) From an actinomycotic mycetoma in Brazil.

Nocardia berestineff Chalmers and Christopherson (Streptothrix cas 1, 11, Berestneff, Inaug. Diss., Moscow, 1897; Chalmers and Christopherson, Ann. Trop Med. and Parasitol., 70, 1916; 263; Discomptes berestneff Brumpt, Précis de Parasitol, Paris, 3rd ed., 1922, 292; Actinomyces berestneff Sartory and Bally, Mycoses pulmonaires, 1923, 256. From a ease of pulmonary pseudotuberculosis

Nocardia bicolor (Trolldenier) de Mello and Fernandes. (Actinomyces bicolor Trolldenier, Zischr. f. Tiermedizin, 7, 1903, 81; de Mello and Fernandes, Mem. Assatie Soc. Bengal, 7, 1919, 1903.) Found in cerebromeningitis, bronchitis and lymphadentiis in a dox.

Nocardia consoluta Chalmers and Christopherson, Chalmers and Christopherson, Ann Trop. Med. and Parasit., 10, 1916, 257, Discompces consolutus Neveu-Lemans, Précis Parasito Hum., 5th ed., 1921, 443; Oaspera consolutus Sartory, Champ. Paras Homme et Anim, 1923, 769; Actinomyces consolutus Parmyth, Précis de Parasitol, Paris, 4th ed., 1927, 1195) From a yellow grain mycetoma of the foot in the Sudan.

Nocardia cylindracea de Korté, (De Korté, Ann Trop, Nied, Parasit, 11, 1918, 205; Discomptes cylindraceus Neveu-Lemaire, Précis Parasitol. Hum, 5th ed., 1921, 41; Oospora cylindracea Sartory, Champ Paras Homme et Anm, 1923, 774, Actinomyces cylindracrus Brumpt, Précis de Parasitologio, Paris, the ed., 1927, 1926) From an inlection of the outer car, resembling mycetoma

Nocardia entertidis (Pottien) Castellam and Chalmers. (Streptothrix enteritidis Pottien, 1902, according to Sanfelice, Cent. f. Bakt., I Abt., Orig. 55.

sanfelicei Nannizzi, in Pollacci, Tratt. Micopat. Umana, 4, 1931, 51.) From fatal lesions in a rat.

Nocardia aplenica Gibson. (Gibson, 1930, quoted from Nannizzi, in Pollacci, Tratt. Micopat. Umana, 4, 1934, 50; Actinomyces splenica Nannizzi, udem.) From a case of splenomegalia.

Nocardia tenuis Castellani, (Castellani, Brit. Jour. Derm. Syphilis, 23, 1911, 341; Discomyces tenuis Castellani, Proc. Roy. Soc. Med, 6, Derm, 1912, 23; Cohnistreptothrux tenus Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 16, 1916, 273; Actinomyces tenuis Dodge, Medical Mycology, St. Louis, 1935, 715.) From cases of trichomycoss fava.

Nocardia valvulae Chalmers and Christopherson (Streptothrix valvulae destruens bovis Luginger, Monats. f. prakt. Tiesheuk, 15, 1901, 289; Chalmers and Christopherson, Ann. Trop. Med. and Parasit, 16, 1916, 263; Oospora calvulae destruens bovis Sartory, Champ. Paras. Homme et Anim., 1923, 783; Actinomyees valvularii Ford, Textb. of Bact., 1927, 211; Actinomyees valvulae Nannizzi, in Pollacci, Tratt. Micopat. Umana, 4, 1934, 51) From endocarditis in cattle

Oospora anaerobies Sartory, (Actinomices sp Butterfield, Jour. Inf. Dis., 2, 1905, 421; Sartory, Champ. Parasit. Homme et Anim., 1923, 830, Actinomyceanaerobies Plaut, quoted from Dodge, Medical Mycology, St Louis, 1935, 717.) From pus from human lung

Ospora bronchialis Sartory and Levasseur. (Sartory and Levasseur, 1914, quoted from Never-Lemaire, Précis Parasitol Hum., 5th ed, 1921, 43; Actinomyces bronchialis Sartory, Bull. Sci. Pharm, 23, 1916, 12, Discompces bronchialis Neveu-Lemaire, iden.) From sputum in a case of pulmonary cosporosis

Oospora buccalis Roger, Bory and Sartory. (Roger, Bory and Sartory, Bull. Mem. Soc. Méd. Hôp. Paris, 27, 1909, 319 and Compt. rend. Soc. Biol. 68, 1909, 301; Discomyces buccalis Brumpt, Précis de Parasitol., Paris, lat ed., 1910, 861; Necardus buccalis Castellani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 819; Actinomyces buccalis Satory and Bailly, Mycoses pulmonaires, 123, 250; From a case of creamy stomatitis with tonsillar abscess.

Osspora catarrhalis Sartory and Bailly. (Sartory and Bailly, Thèse Univ. Strasbourg Fac. Pinstm. 4, 1921, 57; Incomuces catarrhalis Brumpt, Prées de Parasitol, Paris, 3rd ed., 1922, 63, Actinomyces catarrhalis Brumpt, ibid., 4th ed., 1927, 1195.) From sputum is acase of pulmonary cosporosis.

Oospora hominis Ridet. (Streptothris

appendicis Chalmers and Christopherson, Ann. Trop. Med. and Parasit. 16, 1916, 256; Discomyees appendiess Brumpt, Précis de Parasitol., 3rd ed., 1922, 97; Actinomyces appendiess Brumpt, 181d, 4th ed., 1927, 1183. From a case of ampendicitis and an illine abserva.

Oospora lingualis Guéguen. (Guéguen, Compt. rend. Soc. Biol., 64, 1903, 832, Discomptes lingualis Brumpt, Précis de Parasitol., Paris, 1st ed., 1910, 865 and

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mers and Christopherson, Ann. 1179. Med. and Parasitol., 10, 1916, 295, Discompers purgues Brumpt, ibid., 3rd ed., 1922, 989; Actionogers purgues Brumpt, ibid., 4th ed., 1927, 1931, Vocardia guerguesi Ota, Jap. Jour Dem

nigra.
Ospora pulmonalis Roger, Sariory
and Bory. (Roger, Sattory and Bory,
Compt. rend. Soc. Biol., 66, 1909, 150,
Discomyces pulmonalis Brumpt, Précis

de Parasitologie, 1st ed., 1910, 893, Nocardia pulmonalis Castellanı and Chalmers, Man Trop. Med., 2nd ed., 1913, 817, Actinomyces pulmonalis Sartory and Bailly, Mycoses Pulmonaires, 1923, 256.) From the sputum of a patient with pulmonary mycosis.

Oospora pulmonalis var. chromogena Sartory (Sartory, 1913; Actinomyces pulmonalis var. chromogenus Nannizzi, in Pollacci, Tratt. Micopat Umana, 4, 1034, 39.) From sputum of a patient suspected of having pulmonary tuberculosis

Proactinomyces albus Krassilnikov. (Bull Acad. Sci., U. S. S. R., No 1, 1939, 139 ) Cells at first produce mycelium with frequent branching varying in diameter from 0.6 to 1.0 micron Breaks up after 2 or 3 days into rods and sometimes later into cocci. Multiply hy fission, cross-wall formation and budding Does not form spores, cells are Gram-positive and are not acid-fast. Colorless growth Colonies vary up the different strains, somewhat rough, folded, shiny or dull, of a dough-like consistency. Krassilnikov listed several atrains of this organism, including Proactinomyces olioocarbonhilus

Proactinomyces aquosus Turfitt (Jour Bact , 47, 1944, 490 ) From soil Decomposes cholesterol

Proctinomyces cyaneus (Beijerinck) Krassilmkov (Actinosceus cyaneus Beijerinck, Folia microbiol., Deltt. 2, 1914, 190, Krassilnikov, loc. cit.) Blue pigment produced on synthetic media Cells are rod-shaped 0.7 to 0.8 by 3 to 7 micros. Branching cell material on potato multiphies by means of bud formation, by fission, and cross-wall formation; no true stores formed.

Proactinomyces evaneus-antibiolicus Gause (Jour. Bact, 51, 1916, 619) From soil Produces litmocidin, a new antibiolic

Proactinomyces moormani Franklin. (Ann Intern. Med., 15, 1910, 1235) From the pus of multiple molar abscesses in a dental patient.

Proactinomyces paraguagens: Almeida. (Mycopath., 2, 1940, 201.) From a thoracle mycetoma with heavy, dark grains affecting a Canadian patient living in the Paraguayan Chaeo. Sabounud's glucosa agar. Pseudomembranous colony with mised, dark center surrounded hy a white band, progressively increasing in size, and then by a light chocolate area.

Proactinomyces restrictus Turfitt. (Jour. Bact , 47, 1944, 491.) From soil. Decomposes cholesterol.

Proactinomyces sp. Helzer. Found in sputum of tuberculous patient. Pathogenie for guinea pigs and rabbits.

Streptothers buccalis Goadby. (Mycology of the Mouth, London, 1803, 200.) From the mouth in cases of pyorrhoes. Chalmers and Christopherson (Ann. Trop Med. and Parasit, 10, 1916, 234) regard this as a synonym of Nocardia liquifoctens.

Streptohriz flata Chester. (Letinomyces ep Bruns, Cent. t. Bakt., 29, 1890, 11; Chester, Man Determ. Bact; 1901, 362; Necordia brun: Chalmers and Christopherson, Ann Trop. Med. and Parasit., 10, 1916, 256; Steeptohriz hominis Bruns, according to Chalmers and Christopherson, 4dem; Discomyres bruni Brumpt, Précis de Parastol., Paris, 3rd ed, 1922, 992; Actinomyces bruni Brumpt, 19d4, 4th ed., 1937, 1204; Actinomyces Harus Dodge, Medical Mycology, St Louis, 1935, 752.) From pis Irom a case of actinomycesis of the abdomical wall.

Streptokriz Justa Karwacki, (Karwacki, Compit rend, Soe, Biol., 69, 1911, 180, not Streptokriz Jusca Corda, Prachillora europäischer Schimmelbidungen, Leiping and Dreeden, 1839, 27; Nocarda fusca Castellam and Chalmers, Man Trop Med., 2nd ed., 1913, 513, Discompets Juscus Brumpt, Précis de Parastiol., Paris, 3rd ed., 1922, 903; Outpora Jusca Sartory, Champ. Paris.

Homme et Anim., 1923, 809; Actinomyces fuscus Sartory and Bailly, Mycoses pulmonaires, 1923, 256; not Actinomyces fusca Söingen and Fol, Cent. f. Bakt., II Abt., 40, 1914, 87.) From the sputum of a tuberculosis patient.

Streptothriz luteola Foulerton and Jones. (Foulerton and Jones, Trans. Path. Soc. London, 53, 1902, 75; also see Foulerton, Lancet, 1, 1905, 1200 and 1, 1906, 970; Necardia luteola Castellani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 818; Discomyces luteolus Brumpt, Précis de Parasitol., Paris, 3rd ed., 1922, 981; Oespora luteola Sartory, Champ. Paras. Homme et Anim., 1923, 812; Actinomyces luteolus Ford, Textb. of Bact, 1927, 213.) From a lung infection, from a case of conjunctivities, and from a dental abscess.

Streptothriz madurae Solari. (Solari, Semana Méd., 24, 1917, 573; not Streptothriz madurae Vincent, Ann. Inst. Past., 8, 1894, 129; not Streptothriz madurae Koch and Stutzger, Ztschr. f. Hyg, 69, 1911, 17.) From Madura foot. See Actinomyces avadi.

Streptokriz muris-ratii Schottmüller. (Schottmüller, Derm. Wochneshr, & 8, 1914, 77; Nocardia muris de Mello and Pais, Arq. Hig. Pat. Evot., & 1918, 183; Actinomyces muris-ratii Namiri, in Pollacci, Tratt. Micopat. Umaas, 4, 1934, 51.) From sodoku or rat-bite fever.

Streptothriz tarozzii Miescher. (Actisomyces albus Tarozzi, Archivio Sci. Med., 33, 1009, 553; Miescher, Arch. Derm. Syphilis, 124, 1917, 297; Actinomyces tarozzii Dodge, Medical Mycology, St. Louis, 1935, 735.) From a case of Madura foot.

Streptothriz verrucosa (Adler) Miescher. (Actinomyces verrucosu Adler, 1904, see Nannizzi, in Pollacci, Tratt. Mieopat Umana, 4, 1934, 40; Miescher, Arch Derm. Syphilis, 124, 1917, 314.) Fram mycetoma podis

(Harz, in Bollinger, Centbl. f. med. Wissensch., 15, 1877, 485; Harz, Jahresber, d. Munch, Thierarzneischule for 1877-78, 1879, 125; not Actinomyce Meyen, Linnaea, 2, 1827, 442; Discomyces Rivolta, Clinica Veter , Milano, 1, 1878, 208; Actinocladothrix Alanasiev, St. Petersb. med. Wchnschr., 4, 1887, 323; Micromyces Gruber, Cent. f. Bakt , 10, 1891, 648; not Micromyces Dangeard, Le Botaniste, 1, 1888, 55; Actinobactersum Haas, Cent. f Bakt., 1 Abt , Orig , 40, 1906, 180; Carteria and Carterii Musgrave, Clegg and Polk, Philippine Jour. Sci , Ser. B, Med. Sci., 5, 1903, 470; Cohnistreptothrix Pincy (in part), 1911, see Pincy, Bull. Inst. Past., 11, 1913, 929; Anacromyces Castellani, Douglas and Thomson, Jour. Trop. Med. Hvg., 24, 1921. 149; Bremstreptothriz Lignières, Ann Parasit Hum Comp. 2, 1924, 1.)

True mycelium produced. The vegetative mycelium fragments into elements of irregular size and may exhibit angular hranching. No conidia produced. Not acidfast. Anacrobic to microacrophilic. Pathogenic for man and animals,

The type species is Actinomuces bovis Harz.

#### Key to the species of genus Actinomyces.

- I. Colonics soft, smooth, uniform, not adherent to medium. No serial hyphse, 1. Actinomyces boris.
- Il Colonies tougher in texture and warted in appearance, adherent to medium. Scanty acrual growth of hyphae.
  - 2. Actinomyces saracli.

I. Actinomyces boyls Harz, (Harz, in Bollinger, Cont. f med. Wissensch., 15, 1877, 485; Jahrb d. Munch, Thierarzeneischule, 1877, 781 : Discomuces boris Rivolta, La clinica Veterinaria, 1, 1878, 169 or 203; Bacterium actinocladothriz Afanasiev, St. Petersburger Med. Wochnschr., 13, 1888, 81; Nocardia ac-(inomyces Trevisan, I generi e le specie delle Batteriscee, Milan, 1889, 9; Streptotrie actinomyces Rossi Doris, Ann. d. 1st d'Igi Sper., Univ di Roma, 1, 1891, 425: Claduthrix borse Mucé. Traité de Bact., 2nd ed , 1991, 666; Cospora boris Survageau and Radais, Ann. Inst. Past., Paris, 6, 1892, 271; Actinomyces bovis sulphureus Gasperini, Cent. f. Bakt., 15, 1891, CS1; Nocardia boris Blanchard, in Bouchard, Traité de Path, Générale, 2, 1896, 857; Actinamyces sulphureus Gasperini, Atti Soc. Tose, Scienz, Nat., P. V , 11, 1896; Cladothrix actinomyces Mace, Traité de Bact., 3rd ed., 1897, 1038, Streptothrix actinomycolica Foulerton, Lancet, 2, 1899, 780, Streptothriz boris communis Poulerton, Jour. Comp. l'ath. and Therap., 14, 1901, 50; Streptothrix bovis Chester, Man. Determ Bact., 1901, 361, Streptothrix sulphurea Caminiti, Cent. f. Bakt., 1 Abt., Orig . 14, 1907, 197; Sphaerotilus bovis Engler. Syllabus der Psianzenfam., 5 Aufl., 1907, 5; Nocardia sulphurea Vuillemin. Encyclopedie Mycologique, Paris, 2, 1931, 129; Proactinomyces bovis Henrici. Biology of Bact., 2nd ed., 1939, 409.) From Latin botis, of the ov.

Synonyms previous to 1919 as given by Breed and Conn, Jour. Bact., 4, 1919. 596.

Probable synonym: Brevistreptothrix sputzi Lignières, Annales de Parasit , 2, 1924, 2 (Streptothriz spitzi Lignières and Spitz, Cent. f. Bakt , I Abt., Orig , 55, 1904, 453, Actinobacterium isreali var. spitzi Sampietro, Ann. Igiene, 18, 1908. 391; Discomyces spitzi Brumpt, Précis de Parasitol , Paris, 1st ed., 1910, 817; Actinomyces spitzi Lieske, Morphol. u. Biol d Strahlenpilze, Leipzig, 1921. 32; Oospora spitzi Sartory, Champ. Paras Homme et Anim, 1923, 775). Found in mycosis of the upper jaw of oxen in Argentina.

Description from Erikson, Med. Res. Council, London, Special Report Ser. 240, 1940, 63 pp

No acrial hyphac. Radiate, sulfurcolored granules occur in the pus found in cases of actinomycosis. Large clubshaped hyphac are seen in morbid tissues. Gram-positive. Non-motile. Not acidfast.

Mycelium: Undergoes fragmentation very rapidly, extensive branching is rare. Hyphae less than I micron in diameter.

Colonies: Smoother and softer in consistency, and more uniform than in the following species. The colonies are not adherent to the medium and growth is scantier.

Semi-solid media: Excellent growth, especially with paraffia seal.

Gelatin · Occasionally scant, flaky growth. No liquefaction.

Liquid media Occasional turbidity with a light flocculent growth.

Acid from glucose, sucrose and maltose. No acid from salicin and mannitel

Pigments No soluble pigments produced on protein media. No insoluble pigments produced by growth.

Egg or serum media No proteolytic

action

Litmus milk Becomes acid but usually
no congulation, no personization. Some-

No hemolysis in blood broth or blood agar.

Serology No cross agglutination between five bovine strains and human strains of Actinomyces israeli No cross reactions with representative aerobic strains

Optimum temperature 37°C

times no growth

Anaerobic to microaerophilic. Bovine strains are more oxygen-tolerant on egg or serum media than strains of luman origin belonging to the following species

As pointed out by Lignières and Spitz (Bull Soc. cent Méd. vet , 20, 1902, 457 and 546) and others, distinction should be made between the infections produced by Actinomyces boils and those produced by the Gram-negative Actinobacillus nor known as Actinobacillus liquierei. These infections frequently occur in mixed form and are also frequently complicated by the presence of progenic cocci (Magnussen, Acta path. Alterobiol. Scand., 5, 1925, 170; and others).

Source: Originally found in lumpy jaw of cattle.

Habitat: Frequently found in and about mouth of cattle and probably other animals. Lesions may also be produced in the liver, udder or other organs of cattle and hogs. Possibly also in human mouth (Naeslund, Acta path. Microbiol. Scand., 2, 1925, 110).

This and the following species are sometimes regarded as being identical (see Emmons, Public Health Repts, U.S.P.H.S., 53, 1935, 1967; Rosebury, Baet. Rev., 8, 1944, 190; and others).

2. Actinomyces Israell (Kruse)
Lachner-Sandoval. (Simhlengil, Wolfs
and Israel, Arch. f. path, Anal., 186,
1891, 11; Steptothriz israeli Kruse, in
Flugge, Die Mikroorganismen, 3 Auf.
2, 1805, 65; Actinomyces izraeli LacinerSandoval, Inaug. Diss., Strasburg, 1898,
64; Discomyces izraeli Gedoelst, Les
champignons parasites de l'homme et
des animaux domestiques, 1902, 163;

to÷ ur,

Paris, 11, 1913, 931; Nocardus small Castellani and Chalmers, Man. Trop. Med. 2 and ed., 1913, 814; Anaeromyces bronchitica Castellani, Douglas and Thomson, Jour Trop. Med. Hyg. 24, 1921, 195; Cohnisterplothriz bronchitica Verdun and Mandoul, Précis Parasitol, 1921, 754; Brensterplothriz israeli Lignères, Annales de Parasit., 2, 1924, 2; Proactnomyces teraeli Negroni, Comptend. Soc Biol., Paris, 117, 1934, 1239; Corynebacterium israeli Haupt and Zeki, Cent I. Bakt., I Abt., Orig., 150, 1955, Osspora tarceli, quoted from Nannini,

Tratt. Micopat. Umana, 4, 1931, 53; Actinomyces wolff-israel Lentze, Cent. f. Bakt, I Abt., Orig, 141, 1938, 21.) Named for Prof. Israel, one of the original isolators of this organism.

Synonyms previous to 1919 essentially as given by Breed and Conn, Jour. Bact,

4, 1919, 597.

Description from Erikson, Med. Res Council, London, Special Rept Ser 240, 1940, 63 pp.

Erect serial hyphae produced in an atmosphere of reduced ovygen tension. These hyphae are occasionally septate but no definite spores are formed. One mucron or more in diameter. Large club shaped forms are seen in morbid tissues. Gram-positive. Non-mobile Not acid-fast.

Substrate mycelum Initially unicellular and the branches may extend into the medium in long filaments or may, more or less quickly, exhibit fragmentation and characteristic angular branching The latter resembles the similar phenomenon found in Corynehocterium

Colones. These estibit a considerable degree of polymorphism but no stable variants have been established. Tougher in teture than those of Actinomyees bers. Old colonies warted in appearance Adherent to the medium.

Gelatin. Occasionally scant, flaky growth. No liquefaction.

Liquid media: Usually efear.

Acid from sugars. According to Slack (Jour Bact., 14, 1911, 193-209) acid from glucose, maltidose, mannital, sucrose and lactose; according to Nogroni and Bonfiglioil (Physics, 16, 1939, 189) acid from glucose, galactose, lactose, fructose, maltose, raffinose, sucrose and vylose

Pigments: No soluble pigments on protein media. No insoluble pigments produced by growth.

ligg or serum media. No proteolytic action

Litmus milk : Becomes acid but usually

does not clot. No peptonization. Frequently no growth.

No hemolysis.

Serology: No cross agglutination between 12 human strains and bovine strains of Actinomyces. No cross reactions with representative aerobic strains, Optimum temperature 37°C.

Anaerobic to microserophilic

Source: From 2 cases of human actinomycosis (1) A retromavillary tumor, (2) actinomycosis of lung and breast (Wolff and Isreal)

Habitat. From human sources (moutb, tonsillar crypts, etc.). Also reported from various domestic animals such as dogs (Raudet, Ann. Parasit., 12, 1934, 296) and eats (Edington, Vet. Record., 14, 1934, 311).

Appendix: The following names have beenapphed to anaerobic or semi-anaerobic species, with descriptions which do not permit clear separation from the above or from each other.

Actinobacterium meyeri Prévot. (Anaerobe Streptothrix-Art, Meyer, Cont. f Bakt, I Abt., Ong, 60, 1911, 75, Prévot, Ann last. Past, 60, 1938, 303) From fetid pus

Actnomyces discololiatus Gritter. (Gruter, Zischr f. Augenheille, 13, 1933, 477, redescribed by Negron, Mycopathologia, 1, 1938, 81) From lachrymal concretion and human infection

Actinomyces Instruments Sans (Sans 1916, quoted from Dodge, Medical Mycology, St. Louis, 1935, 731, Novardia Instruments de Mello and Pens, Arq. Hig. Pat. Not., 6, 1918, 178). From glauduar and gaughtonar actinomycosis of the ox. Regarded as a variety of Actinomyces boxis.

Actinomyces thousand Dodge, (Cohn.).

Actinomyce injecture Bouge. (Connistreptothriz ap or Streptothriz ap. Thjøtta and Gundersen, Jour. Bact., 10, 1925, 1, Dodge, Medical Mycology, 1935, 713) I rom the blood in a case of acute theumatism Cohnistreptothriz nescheradimenki (sie)
Chalmers and Christopherson. (Eine
Streptothrix, Nescheradimenko, Cent. I.
Bakt., I Abt., Orig., 46, 1908, 573;
Chalmers and Christopherson, Ann.
Trop. Med., 10, 1916, 273; Actinomyces
nescheradimenki Dodge, Medical Mycology, 1935, 712; Actinobetterium abscesservent and the servent and the

Discomyces corougeaui Gougerot.
Gougerot, Compt. end. Soc. Bol.,
Paris, 67, 1909, 589; Nocardia carougeaui
Castellani and Chalmers, Man. Trop.
Med., 2nd ed., 1913, 817; Cohnistreptothriz carogeanui (sico) Chalmers and
Christopherson, Ann. Trop. Med., 10,
1916, 273; Streptohriz carougeanui Greco,
Origine des Tumeurs, 1916, 724; Actinomyces carougeaui Brumpt, Précis de
Parasitol., 4th ed., 1927, 1200) From
a human infection.

Discompces thibiergei Ravaut and Pinoy (Ravaut and Pinoy, Ann. Derm. et Syph., 10, 1900, 417; Nocordio thibiergei Castellani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 817; Cohnsteptchriz Inbiergei Pinoy, Bull. Inst. Past., 11, 1913, 393; Osopora thitiegal Sartory, Champignons Parasites de PHomme et des Animaux, Fasc. 11, 1923, 792; Actinomyces Inbiergei Greco, Origine des Tumeurs, 1916, 723.) From a human infection.

Streptothrix cuniculi (Schmorl, Deutsch, Ztschr. f. Thiermed. 17, 1891, 375; Actinomyces cuniculi Gasperini, Ann. Ist. Ig. sper. Univ. Roma, 2, 1892, 222; Cladothriz cunicult Macé. Traité de Bact., 6th ed . 2, 1913, 753: Cohnistreptothriz cuniculi Chalmers and Christopherson, Ann. Trop. Med. 10. 1916. 273: Nocardia cuniculi Froilsai de Mello and Fernandes, Mem. Asialie Soc. Bengal, 7, 1919, 107; Oospora cuntruls Sartory, Champignons parasites de l'Homme et des Animaux, Fasc. 11, 1923, 824.) From infections in rabbits. Generally regarded as probably identical with Spherophorus necrophorus (Flügge) Prévot. See page 678.

# FAMILY III. STREPTOMYCETACEAE WAKSMAN AND HENRIGI.\* (Jour. Baet., 46, 1943, 339.)

Vegetative mycelium not fragmenting into hacillary or ecceoid forms. Conidia borne on sporophores. Priminily soil forms, sometimes thermophilic in rotting manure. A few species are parasitie.

Key to the genera of family Streptomycetaceae.

Conidia produced in aerial hyphae in chains.

Genus I. Streptomyces, p 929.

II. Conidia produced terminally and singly on short conidiophores.

Genus II. Micromonospora, p. 978.

#### Genus 1 Streptomyces Walsman and Henrici.

(Streptothriz Cohn, Beitr. zur Biol der Pflanzen, I. Heft 3, 1875, 186; not Streptothriz Corda, Prachtflora Europaescher Schimmelbildung, 1839, Nocardia Wright, Jour. Med. Research, 15, 1905, 319; Nocardia Wrislow et al., Jour. Bact, 2, 1917, 554; not Nocardia Trovisan, I gener, e le specie delle Batteriace, 1839, 9; Cohniteriptothriz (Group I) Ornkov, Investigations in the Morphology of the Ray Fung. Copenhagen, 1923, 147; not Cohnistreptothriz Pinoy, In Liegard and Landrieu, Bull Soc. Opti, 24, 1911, 253 and Bull Inst. Past., 11, 1913, 292; Aerothriz Wollemweber (in part), Ber deut. Bot Gesel, 39, 1921, 20; Fuactionopiece Langeron (in part), Nouv. Traité de Méd., 4, 1922; Waksman and Henriel, Jour. Bact, 46, 1913, 339)

Organisms growing in the form of a much-branched mycelium with a typical aerial mycelium. Condiospores formed in chains. Aerobie. Saprophytic soil forms, less commonly parasitic on plants or animals.

This genus can be divided, on the basis of the structure of sporulating hyphae, into five groups

Group Straight sporulating hyphae, monopodial branching, never producing regular solvals.

Group 2. Spore-bearing hyphae arranged in clusters,

Group 3. Spiral formation in aerial mycelium; long, open spirals.

Group 4. Spiral formation in aerial mycelium; short, compact spirals.

Group 5 Spore-bearing hypliae arranged on myechum in whorls or tufts.

The type species is Streptomyces albus (Rossi Doria emend Krainsky) Walaman and Ilennei

#### Key to the species of genus Streptomyces.

I Saprophytes; psychrophilie to mesophilie.

A. Soluble pigment on organic media faint brown, golden-yellow, or hluo; pigment may also be absent entirely.

 Pigment absent, or faint brown pigment formed at first and later lost; acreal mycelium abundant, white

1. Streptomyces albus.

2 Pigment blue or red, when present. The red (insoluble) phase occurs when the reaction is distinctly acid, the blue (soluble) phase when it is alkaline.

2. Streptorayces coelicolor.

Revised by Prof. S. A. Walsman, New Jersey Experiment Station, New Brunswick, New Jersey and Prof. A. T. Henricl, University of Minnesota, Minneapolis, Minnesota, May, 1943.

- Pigment at first green becoming brown; aerial mycelium usually absent.
  - 3. Streptomyces verne.
- Pigment yellowish green; growth on synthetic agar penetrating into medium, pink.
  - 4. Streptomyces californicus.
- Pigment golden-yellow; growth on synthetic agar yellow, with yellow soluble pigment.
  - 5. Streptomyces flaveolus.
- Pigment brown (only nn certain protein media, as gelatin, glucose broth).
  - Grown on synthetic agar red to pink. Scant, white serial mycelium.
    - 6. Streptomyces bobiliae.
  - aa. Growth on synthetic agar colorless; nerial mycelium thm, rose-colored.
  - 7. Streptomyces roseochromogenus.
    saa. Growth on synthetic agar me.use-grsy; powdery serial myce-
  - lium.

    8. Streptomyces griscolus.
  - gana. Growth on synthetic agar white turning yellowish, serial mycelium white.
- 9. Streptomyces erythreus.
- B. Soluble yellow pigment on Ca-malate agar.
  - Proteolytic action strong in milk and gelatin.
     Yellow pigment formed.
    - b. Cellulose decomposed; atarch is hydrolyzed.
      - · 10. Streptomyces cellulosae
    - bb. Cellulose not decomposed.
    - 11. Streptomyces parvus.
- Proteolytic action weak.
   Streptomyces malenconi.
- C. Soluble brown pigment formed on synthetic agar.
  - 1. Yellowish-green pigment on potato.
  - 13. Streptomyces diastaticus
    2. Red-brown pigment on potato plug.
- 14. Streplomyces fimicarius.
- D. Greenish-yellow solul le pigment formed; sulfur-yellow pigment on potate.

  15. Streptomyces flavoriens.
- E. Soluble brown pigme at formed in all media containing organic substances
  - 1 Pigment deep lirown (chromogenic type).
    a Pigment faint brown on organic media, becoming greenish.
    - a Pigment faint brown an organic media, becoming electronic brown to black, reddish aerial mycelium on glucose agre-16 Strentomyces olivochromogenus.
    - as. Aerial mycelium yellowish with gray margin; weak diastatic action.
      - action.

        17. Streptomyces diastatochromogenes.
    - ana. Aerial mycelium yellowish; diastatic action weak.
    - 18. Streptomyces flatochromogenes.
      aaaa. Aerial my lium gray; sporophores in clusters; strongly anti-
      - 19. Streptomyces antibioticus.

- 2. Growth and aerial mycelium green on synthetic agar.
  20. Streplomyces piridochromogenes.
- Deep brown to black pigment on synthetic agar.
   Orange-red on potato, no aeraal mycelium
  - a. Orange-red on potato, no aerial mycelium on synthetic agar; growing feebly

    21. Streptomuces purposchromogenus.
  - aa. Brown to black on potato; ahundant cottony acrial mycelium
    - on synthetic agar
      - b. Brown ring on milk culture; congulated; peptonized
        22. Streptomyces phaeochromogenus
    - bbb. Black ring on milk, no coagulation; peptonization doubt-

### 23. Streptomyces aureus.

et. Red to rose-red pigment on glueose, maltose, and starch agar.

24. Streptomyces erythrochromogenes.

e3. Lavender-colored aerial mycelium. 25. Streptomyces latendulae

c2. Growth on potato gray with black center.

26 Streptomyces reticuli.

cs. Growth on potate cream-colored, becoming pink to dark red.

27 Streptomyces rubrireticuli.

c. Growth on potato greenish-olive

d Aerial mycelium straw-colored
28 Streptomuces flavus.

dd. Aerial mycelium chrome-orange.

29. Streptomyces ruber.

F No soluble pigment formed on gelatin or other media.

 Proteolytic action strong in milk and gelatin.

- at Yellowish-green growth on starch with pinkish aerial mycellum
- 30. Streptomyces extreus
  at Golden-yellow growth, later becoming orange to red-brown, on
  synthetic media
- 31 Streptomyces fulrissimus
- a. Cream-colored growth on starch media 32. Streptomyces gougeroli.
- a\*. Bluish-black color on synthetic media, with white serial myce-lium.

## 33 Streptomyces violaceoniger

a. Yellowish pigment on potato.
 b. Aerial mycelium thick, powdery, water-green; starch is hydrolyzed

34. Streptomyces griseus.

bb. Aerial mycelium white; starch weally hydrolyzed.
35. Streptomyces griscoffacus.

- 86. Greenish-black pigment on potato; aeral my celium white.

  36. Streptomuces olbidoffarus.
- a\*. Reddish-brown pigment on potato; actual mycellium white;

37 Streptomyces poolensis.

399; Cladothrix alba Mace, Traité Pratique Bact., 3rd ed., 1897; Actinomyces albus Krainsky, Cent. f. Bakt., II Abt., 41, 1914, 662; Nocardia alba Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 270; Waksman and Henrici, Jour. Bact., 46, 1913, 339.) From Latin albus, white.

Additional synonyms as given by Baldacci (Myconathologia, 2, 1940, 156): Cladothriz dichotoma Mace, nat Cohn, 1886; Streptothriz foersteri Gasperini, pot Cohn, 1890; Streptothrix No. 2 and 3. Almquist, 1890; Actinomyces saprophyticus Gasperini, 1892; Oospora dorige Sauvageau and Radais, 1892; Cladothriz liquefaciens Hesse, 1892 (according to Duché); Cladothriz invulnerabilis Acosta and Grande Rossi, 1893; Actinomyces chromogenus Gasperini, 1894 (Streptotrix nigra Rossi Doria, 1891); Streptoacdanensis I Scheele Petruschky, 1897; Streptothrsz graminearum Berestneff, 1898; Actinomyces thermaphilis (Berestneff) Miche, not Gilbert, 1898; Cladothrix adorifera Rullmann. 1898; Actinomyces chromogenes Gasperiui 8 alba Lehmann and Neumann, 1899; Oospora sp. Bodin, 1809 (according to Duché); Oospora alpha Price-Jones, 1900 (according to Chalmers and Christopher-80n); Streptothriz leucea Foulerton, 1902 (according to Chalmers and Christopherson): Streptothriz candida Petrusehky, 1903; Streptothrix lathridii Petruschky, 1903: Streptothrix dassonrillei Brocq-Rousseau, 1907 (according to Duché); Streptothrix pyogenes Caminiti, 1907 (according to Chalmers and Christopherson); Streptothriz sanninii Ciferri, 1922; Actinomyces almquisti Duché, Actinomyces gougeroti Duché. 1934. Doubtful synonyms: Gospora metchnikowi Sauvageau and Radais, 1892; Oospora guignardi Sauvageau and Radais, 1892; Actinomyces albus Waksman and Curtis, 1919; Actinomyces thermodiastalicus Bergey, (1919) 1925. Varieties: Actinomyces albus var acidus Neukirch, 1902 (according to Nannizzi); Actino-

myces albus var. ochroleucus Neukirch. 1902 (according to Wollenweber); Actinomyces albus var. toxica Rossi, 1905: Actinomyces albus var. (Krüger) Wollenweber, 1920; Aclinomyces albus var. a Ciferri, 1927.

More complete information regarding these species will be found in the text or

in the Appendix to Genus Streptomuces. The description of this species by Rossi Doria is incomplete. The characters given below are taken from Krainsky (loc. cit.) with some supplementary information from later authors. Other descriptions which may vary from this in certain details are given by Waksman and Curtis (Soil Sci., 1, 1916, 117), Bergey et al. (Manual, 1st cd., 1923, 367), Duché (Les actinomyces du groupe albus, Paris, 1934, 257) and Baldacci (los est).

Vegetative hyphae: Branched, I micron in diameter.

Aerial mycelium: Abundant, white. Hyphae 1.3 to 1.7 microns in diameter with ellipsoidal spores (I micron long) in coiled chains on lateral branches of the actial hyphse.

Gelatin: Liquelaction. Colonies gray,

no soluble pigment.

Ca-malate agar: Colonies of medium size, the center only is covered with a white aerial mycelium.

Starch agar: Aerial taycelium white but covers the whole si riace.

Glucose agar: Gray terial mycelium becoming brownish.

Peptone and bouilim agar: No aerisl mycelium but a chalky white deposit forms on old colonies.

Odor: Earthy or musty.

Broth: Flaky growth on bottom with surface pellicle in old cultures.

Potato: Colonies and aerial mycelium

white. Carrots and other vegetables: Excellent growth (Duché).

No growth on cellulose. No hydrolysis of starch. Actively proteolytic.

Nitrites produced from nitrates.

Milk: Peptonized after coagulation. Reaction becomes alkaline (Duché).

Aerobic.
Source: From air and soil (Rossi
Dona); from garden soil (Krainsky).
Habitat Dust, soil, grains and straw.

Widely distributed.

2 Streptomyces coelicolor (Reiner-Muller) comb. nov. (Streptohrtz ceetcolor Reiner-Muller, Cent. I. Bakt, 1 Abt, Orig., 46, 1908, 197, Nocardia coetheolor Chalmers and Christopherson, Aum Trop. Med. and Parsatt, 10, 1916, 271, Actnomyces colicolor Luesko, Morphol u. Biol d. Strahlenpiles, Leiping, 1921, 23) From Latin caelum, sky and color, color.

Regarded by the authors of this section as the same as Actinomices violaceus Wakeman and Curtis, Soil Science, 1, 1916. 110 (Actinomyces violaceus-ruber Waksman and Curtis, ibid , 127, Actinomuces wakemanni Bergey et al . Manual. 3rd ed . 1930, 489) and Actinomyces tricolor Wollenweber, Arbeiten d Forschungsinstitut für Kartoffelbau, 1920, It is, however, pointed out by J. E. Conn (Jour. Bact , 46, 1913, 133) that certain differences between the descriptions of Waksman and Curtis, and that of Muller may correspond to actual chemical differences in the pigments produced; and that the organism of Waksman and Curtis may be a separate species.

Description by Müller except as noted

Morphology of Streptomyees codicator has not been fully described. According to Waksman and Curtis who described Actinomyees riolaccus-ruber, this is as follows: Straight filaments with open, dectrose spirals, breaking up into conidia Condida oval or rod-shaped, 0.7 to 1.0 by 0.8 to 1.5 microns.

Gelatin Good growth. No pigment formation Liquefaction fairly rapid, beginning in 4 to 7 days.

Plain agar: Good growth. Pigment lacking or faint blue (Conn). Czapek agar (according to Waksman and Curtis concerning Actinomyces tolaceus-ruber): Thin, spreading, colories at first, becoming red, then blue. Aerial mycelum thin, white, powdery, becoming mouse-gray.

Asparagine agar (synthetic). With glycerol as source of earbon, good growth, violet to deep blue, with pigment diffusing through medium; final H-ion concentration about plf 70 to 8.0. With glucose as source of earbon, poorer growth, red, no diffusion of pigment; final H-ion concentration about plf 60 to 50 (Conn).

Broth. Good growth. Cretaceous layer around edge.

Milk. No change at 25°C (Conn). At 37°C, congulation Peptonization beginning in 3 to 5 days.

Potato. Strong pigment production, sometimes greenish-blue or violet, but usually sky-blue, diffusing through medium and coloring water at base of tube. Nutrites produced from nitrates.

Blood agar: Hemolysis showing on 4th

Muller reports no acid from carbolydratesonorganic media. Conn, however, finds acid from glucose and lactose, and sometimes from sucrose and manifol when grown on synthetic media

Pigment: The most striking characteristic of this organism is a litmus-like pigment usually produced on potato or synthetic media, which is deep blue and water-soluble at alkaline reactions (beyond pH 80), violet around neutrality, and red (insoluble in water) at about pII 60. Conn points out that the primary pigment has a spectrophotometric curve almost identical with that of agolitmin; but that there are undoubtedly other picmenta produced, especially in the case of the strains believed to be typical of Actinomyces violaceus ruber fas previously pointed out by Waksman and Curtis).

Good growth at room temperature and at 37°C. Optimum temperature 37°C. Habitat: Soil.

 Streptomyces griseolus (Waksman) comb. nov. (Actinomyces 96, Waksman, Soll Science, 8, 1919, 121; Actinomyces griseolus Waksman, in Manual, 1st ed., 1923, 369.) From Latin griseus, gray and colus, diminutive ending; hence, somewhat gray.

Branching mycelium; no spirals observed. Conidia spherical or oyalshaped.

Gelatin stab: Liquefied with yellowish, flaky pelliele and sediment.

Synthetic agar: Colorless, thin, spreading growth, chiefly in the medium; surface growth limited almost entirely to the aerial mycelium. Aerial mycelium at first gray, later becoming pallid, neutral-

gray.
Starch agar: Grayish-brown growth,

with dark ring.
Glucose agar Spreading growth, both
on the surface and into the medium;
center raised, cream-colored, turning

dark. Plain agar: Brownish growth, with

smooth surface.
Glucose broth · Thick, brown ring.

Litmus milk: Abundant growth, pink pellicle; coagulated; peptonized, becoming alkaline.

Patato: Cream-colored growth, becoming black, spreading

Nitrites produced from nitrates.
Faint brownish soluble pigment

formed. Starch is hydrolyzed.

Aerobic.

Optimum temperature 25°C.

Habitat : Soil.

 Streptomyces crythreus (Waksman) comb. nov. (Actinomyces 161, Waksman, Soil Science, 8, 1919, 112; Actinomyces crythreus Waksman, in Manual, 1st ed., 1923, 370; Actinomyces krainskir Duché, Encyclopédic Mycologique, Paris, 6, 1934, 306.) From Greek crythrus, red. Mycelium fine, branching; numerous open spirals formed as side branches of the main hyphse.

Gelatin stab: Abundant, dense, gray growth with pickish tinge, chiefly on surface of liquefied medium.

Synthetic agar: Spreading growth with irregular margin, developing deep into the medium; color at first white, later turning yellowish, agar around growth has a white, milky surface. Aerial mycelium, thick, solid, white.

Starch agar: Cream-colored, circular colonies, with faint greenish tinge.

Glucosc agar: Abundant, spreading, cream-colored growth, later turning brown chiefly on surface; center raised, lobate margin.

Plain agar: Cream-colored growth Glucose broth: Abundant, cream-

colored surface growth.

Litmus milk: Yellowish surface zone;
coagulated; peptonized, becoming alksline.

Potato: Wrinkled, cream-colored

growth, becoming yellowish.

Nitrites produced from nitrates.

Soluble purple pigment formed.

Starch is bydrolyzed. Aerobic.

Optimum temperature 25°C.

Similar to Streptomyces erythrochromogenes (Species No 24) except that no brown soluble pigment is formed.

Source: From California and Hawaiian soils

Habitat: Soil.

Streptomyces cellulosae (Krainsky) comb. nov. (Actinomyces cellulosae Krainsky, Cent. f. Bakt, II Abt, 41, 1914, 662.)
 From M. L. cellulosa, cellulosa.

Conidia almost spherical, 13 microns in diameter, often arranged in chains Gelatin colonies: Circular, yellowish Gelatin stab. Liquefied.

Plain agar: White aerial mycehum. Ca-malate agar: Yellowish colonies; gray aerial mycelium. Soluble yellow pigment formed.

Glucose agar: Abundant growth, gray acrus mycelium Soluble yellow pugment Starch agar: Same as on glucose agar.

Glucose broth: Coarse, flaky growth Yellow pigment.

Latmus milk · Peptonized.

Potato: Light gray growth; gray aeral mycelium. Nitrates show slight reduction.

Strong dustatic action. Esculin is hydrolyzed.

Cellulose is decomposed.

Acrobic.

Optimum temperature 30° to 35°C Habitat Soil.

11. Streptomyces parws (Krainsky). comb nov. (Actinomyces parws Krainsky). Cent. f. Bakt., Il Aht., 41, 1914, 662, Nocardia parez Chaimers and Climstopherson, Ann Trop. Med. and Parastt, 10, 1916, 268) From Latin parsus, small.

small.

Conidia more or less oval, 0.9 to 1.3
by 1.2 to 1.8 microns.

Gelatin: Colonies yellow. Slow liquefaction

Ca-malate agar · Small, yellow colonies with light yellow serial mycelium Glucose agar : Same as on Ca-malate

sgur Starch agar: Same as on Ca-malate

agar.
Glucose broth: Hemispherical colonies

in bottom of tube.

[atmus milk: Peptonized
Natrate slightly reduced.

Moderate disstatic action. Cellulose not decomposed.

Aerobie.

Optimum tempemture. Source Garden soil.

Habitat · Soil.

12 Streptomyces malenconii (Duché) comb nov. (Actinomyces malencons Duché, Encyclopédie Mycologique, Paris, 6, 1931, 353.) Named for Mr. Malençon from whom the original culture was obtained.

Gelatin. Poor growth; liquefaction.

Asparagine glucose agar: Rapid opaque growth, later becoming covered with white acrial mycellum; amber-colored nigment, dissolved in medium.

Peptone agar: Cream-colored lobous growth, covered with whitish aerial mycelium.

Asparagine glucose solution Long, much branching filaments, 0.5 to 0.7 micron, somewhat beavier serial mycelum with a few irregular condus; some flaky growth on bottom of tube; surface growth is cream-colored with rare white aerial mycelium; inquid becomes slightly yellow.

Peptone solution. Whitish growth with yellowish soluble pigment

Milk. Surface growth with whitish aerial mycelium; slow peptonization, liquid becoming brownish-colored.

Potato. Rapid growth with thin white mycelium; no soluble pigment.

Congulated serum. Radiating creamcolored growth covered with white aerial mycelium, slow liquefaction

No pigment on tyrosine medium Source. Culture obtained from Mr. Malencon, an inspector in Morocco.

13 Streptomyces distributes (Krainsky) comb. nov. (Actinomyces distributes Wirsinsky, Cent f. Bakt., II Bakt., 41, 1914, 662; Waksman and Curtis, Soil Science, 1, 1916, 116.) From M. L. distributes, dinstatic.

Actinomyces roseodiastaticus Duché, L'ncyclopédie Mycologique, Paris, 6, 1934, 329 is said to differ from both Krainsky's, and Waksman and Curtis' strains.

Filaments may show fine, long, narrow spirals. Conidia oval, 10 to 1.2 by 1.1 to 1.5 microns.

Gelatin stab. Liquefied with small, eream-colored flakes in liquid.

Synthetic agar: Thin, gray, spreading

growth. Aerial mycelium white, becoming drab gray. Starch agar. Thin, colorless, apreading

Glucose agar: Yellowish, spreading growth. No aerial mycelium.

growth. Aerial mycelium gray.

Plain agar: Cream-colored growth. Thin aerial mycelium.

Glucose broth: Gray ring with gravish colonies in bottom of tube.

Litmus milk: Brownish ring; congulated; peptonized in 25 to 30 days, becoming faintly alkaline.

Potato: Abundant, wrinkled, creamcolored growth with greenish tinge. Nitrites produced from nitrates.

Brown to dark brown soluble nigment formed.

Starch is hydrolyzed.

Aerobic.

Optimum temperature 37°C.

Habitat . Soil.

14. Streptomyces fimicarius (Duché) nov. (Actinomyces fimicarius Duché, Encyclopédie Mycologique, Paris, 8, 1934, 346 ) From Latin fimus, dung and carus, loving.

Gelatin: Punctiform colonies with whitish aerial mycelium; reddish soluble pigment Liquefaction.

Asparagine agar. Cream-colored growth with whitish aerial mycelium; reverse side, cream-colored to slight othre.

Czapek's agar · Yellowish masses of growth with yellowish-white serial mycelium : reverse side orange-colored , faint yellowish soluble pigment

Pentone agar: Cream-colored growth with white serial mycelium; reverse side. vellowish.

Asparagine solution. Vegetative filaments 0 5 to 0.6 micron long; branching aerial mycelium 0.8 to 1 0 micron, forming numerous conidia; flaky growth produced on bottom; surface growth becomes covered with a white serial mycelium: reverse side, brownish-red.

Czapek's solution: Cream-colored

punctiform growth with yellowish acrisl mycelium; no soluble pigment.

Pentone solution: Whitish growth that flakes throughout liquid; yellowish pigment.

Tyrosine medium: White growth with vellowish reverse; yellowish soluble pigment.

Milk: Colorless growth becoming covered with whitish aerial mycelium; slow peptonization of milk which becomes rosecolored, finally changing to brownish red Potato: Cream-colored to yellowish

growth with whitish aerial mycelium; reddish-brown pigmentation of pluz.

Coagulated serum: Cream-colored growth with whitish aerial mycelium; rapid liquefaction of serum.

Distinctive characters: Abundant growth upon neutral and acid media; whitish acrial mycelium: marked odor; soluble brownish-red pigment. This spe cies seems to form the transition type between the Actinomyces albus group and the Actinomyces chromogenus group. Habitat . Found abundantly la manure.

15. Streptomyces flavovirens (Waksman) comb. nov. (Actinomyces 123, Waksman, Soil Science, 8, 1919, 117; Actinomyces flavovirens Waksman, in Manual, 1st ed., 1923. 352; Actinomyces albeviridis Duché, Prcyclopedie Mycologique, Paris, 6, 1931, 317.) From Latin flavus, yellow and virens, becoming green

Large masses of minute tufts; the hyphae coarse, straight, short, relatively unbranched, beaded, open spirals may be produced in certain substances. Conidis spherical, oval to rod shaped, 0 75 to 10 by 1.0 to 1 5 microns.

Gelatin stab Yellowish green surface pellicle, consisting of a mass of small colonies, on the liquefied medium.

Synthetic agar: Growth spreading deep into the substratum, yellowish with greenish tinge. Aerial mycelium, gray, powdery.

Starch agar: Greenish-yellow, spreading growth, developing deep into the medium.

Glucose agar: Restricted growth, developing only to a very small extent into the medium, yellow, turning black, edge entire.

Plain agar. Yellowish growth; the reverse dark in center with yellowish zone and outer white zone.

Gluense broth: Thick, sulfur-yellow

pellicle or ring.

Litmus milk: Cream-colored to brown-

ish ring, coagulated; peptonized, becoming faintly alkaline.

Potato; Sulfur-yellow, wrinkled

growth
Only a trace of nitrite is formed from

nitrates.
Greenish-yellow soluble pigment

formed soluble pign

Starch is hydrolyzed.

Aerobic Optimum temperature 25°C Habitat Soil.

16 Streptomyces olivochromogenus (Bergey et al.) comb. nos (Actinomyces chromogenus 203, Walsaman, Soil Science, 8, 1019, 100, Actinomyces olivochromogenus Bergry et al., Manuvil, 2nd ed., 1925, 308.) From Greek, producing an olive color

Pilaments with numerous close spirals Conductival or elliptical.

Gelatin stab Cream colored, spreading surface growth. Rapid liquefaction

Synthetic agar. White, apreading growth Aerial mycelium ash gray with brownish tinge.

Starch agar Transparent, spreading growth

Glucose agar Abundant, natal brown to almost black growth, entire margin Plan agar Wrinkled, brown growth,

becoming gray-green
Glucose breth Thin, brown growth,

flacese brelli Thin, brown growth

Litmus milk Dark brown ring; corgulated; poptonized, becoming alkaline.

Putato Small, wrinkled, black colonies.

Faint traces of nitrates formed from nitrates.

Soluble brown pigment formed.
Starch is hydrolyzed.
Acrobic.

Optimum temperature 37°C. Habitat: Soil.

 Streptomyces diastatochromogenes (Krainsky) comb. nov. (Actinomyces diastatochromagenes Krainsky, Cent f. Bakt, II Abt., 41, 1914, 682.)
 From Greck, probably intended to mean producing both diastase and color.

Conidia apherical or oval, about 1.2

Galatin colonies · Light gray-colored.

Gelatin stab; Liquefied. Plun agar: Medium sized colonics,

with white to gray serial mycelium.

Ca-malate agar · Medium sized colonies,

colorless, with gray aerial mycelium. Glucose agar: Same as on Ca-malate

agar Starch agar · Same as on Ca-malateagar. Glucose broth · Flaky colonies in depth

at first, later also over surface.

Potsto: Light gray colonies, gray aerial

myrelium, medium colored black.
Soluble brown pigment formed in celatin

Weakly diastatic.
No growth on celluloso.

Tyrounase formed.

Aerobic.

Optimum temperature 35°C.

Habitat. Soil.

18 Streptomyces flavothromogenes (Krainaky) comb now. (Actinomyces Rasochromogenes Kraineky, Cent. f. Bakt., II Abt., 41, 1914, 662.) From Latin flavus, yellow and Greek, producing color

Conidia oval, 17 microns. Gelatin colonies Yellowish colonies.

Gelatin colonies Yellowish colonies. Gelatin stab: Slight inquefaction.

Plun agar: Aerial mycelium formed late, at first white, later gray. Gray soluble pigment formed.

Ca-malate agar: Colonics yellow with white aerial mycelium forming late.

Glucose agar: Brown soluble pigment formed.

Starch agar: Yellow colonies, with white aerial mycelium

Glucose broth: Fine flakes, with small spherical colonies adherent to glass. Medium colored brown.

Potato: Yellow colonies, with white aerial mycelium

Nitrites produced from nitrates.

Weakly diastatic. Esculin acted upon. Slow growth on cellulose

Tyrosinase formed.

Aerobic.

Optimum temperature 35°C Habitat: Soil.

19 Streptomyces antibioticus (Waksman and Woodruff) comb. nov. (Actinomyces antibioticus Waksman and Woodruff, Jour Bact., 42, 1941, 232 and 246) From Greek, antibiotic.

Spore-bearing hyphae produced in the form of straight nerial hyphae. The coniduophores are arranged in clusters; no spirals formed. The conidus are nearly spherical to somewhat cllintical.

Gelatin: Dark brown growth on surface, with patches of gray aerial mycellium. Dark pigment produced, which gradually diffuses into the unliquefied part of the gelatin. Liquefaction at first very slow, later becoming rapid

Czapek's agar: Thin, whitish growth. Thin, gray aerial mycelium.

Peptone media. Production of dark pigment at early stage of growth is very characteristic. Growth brownish, thm, with a yellowish-gray to yellowish-green aerial mycelium

Potato plug: Folded, brown-colored growth, with a thin black ring on plug, fading into a bluish tinge No aerial mycelium

Carrot plug. Cream-colored to faint brownish growth. No aerial mycchum. No pigment.

Littuus milk Thick, brownish ring on surface of milk Mouse-gray aerial mycelium with greenish tinge; growth becomes brown, especially in drier perious adhering to giass. No reaction charge, no coagulation of milk, no clearing; shit ish sediment at bottom of tube. Oldcultures: Heavy growth ring on surface of milk, heavy precipitation on bottom; he quid brownish to black in upper perion.

Odor: Very characteristic soil odor. Antagonistic properties: Has a market antagonistic effect on Gram-positive and Gram-negative bacteria, much more on the former than on the latter, as well as on actinomycetes. It is also active against fungi, which vary in degree of sensitivity Produces a specific bacteriostatic and bactericidal substance known as actinomycin. (Waksman and Woodruft, Jost. Bact., 40, 1940, 581).

Source: Isolated from soil on Escherchia celi-washed agar plate, using living cells of E. celi as the only source of available nutrients.

Habitat : Soil.

20. Streptomyces viridochromogenet (Krainsky) comb. nov. (Actinomycettiidochromogenes Krainsky, Cent. 18th, II Abt., 41, 1914, 682, Waksman and Curtis, Soil Science, 1, 1916, 114) From Latin, green and Greek, producing color

Filaments with numerous open spirals, 3 to 5 microns in diameter, occurring as side branches and terminal condis, short ovals or spheres, 1 25 to 1.5 microns.

Gelatin stab: Cream-colored surface growth, becoming greenish. Slow liquefaction.

Synthetic agar: Spreading grouth, cream-colored with dark center, becoming dark green; reverse yellowish to ight cadmium. Aerial mycelium abudant, spreading, white, becoming light green

Starch agar: Circular, spreading, yellowish colonies.

Glucose agar: Abundant, spreading, wrinkled, gray growth, becoming black Plain agar: Abundant, restricted, gray

growth, with greenish tinge.

Glucose broth: Dense, solid ring, brownish, becoming dark green.

Litmus milk: Dark brown surface growth, coagulated; peptonized, with faintly alkaline reaction

Potato · Abundant, gray-brown growth Nitrates produced from nitrates Soluble brown pigment formed Starch is hydrolyzed

Aerobic

Optimum temperature 37°C. Habitat . Soil

21. Streptomyces purpeochromogenus (Waksman and Curtis) comb nov. (Actinomyces purpeochromogenus Waksman and Curtis, Soil Science, 1, 1916, 113.) From Latin, purple and Greek, producing color Branching mycelium and hyphae with

few Imperfeet spirals. Conidia spherical, 0 75 to 1 0 micron in diameter.

Gelstin stab. Slow, brownish surface growth Slow hauefaction

Synthetic agar: Slow, restricted, smooth, gray growth, becoming brown with purplish tinge; center raised Margin yellow.

Starchagar Small, dark brown colonies. Glucose agar. Abundant, restricted, gray growth, becoming brown to dark brown.

Plain agar Gray to brownish growth, becoming dark brown, almost black.

Glucose broth: Slight, flaky sediment. Litmus milk Dark-brown ring; coegulated, slowly peptonized, with faintly alkaline reaction

Potato Restricted, orange to orangered growth.

Nitrites not produced from nitrates.

Soluble dark brown pigment formed. Starch shows slight hydrolysis. Acrobic.

Optimum temperature 25°C. Source, Isolated once from California adobe roil.

Habitat : Soil

22. Streptomyces phaeochromogenus (Conn) comb. nov (Actinomyces pheochromogenus (sic) Conn. N. Y. State Agr. Exp Sta. Tech. Bull No 60, 1917. 16) From Greek, producing a brown color.

Branching filaments and hyphae, spirals narrow, open, elongated, sinistrorse.

Gelatin stab: Abundant, spreading, cream-colored surface growth, becoming brown, Slow liquefaction.

Synthetic agar: Colorless growth, be coming brown to almost black. Aerial mycelum abundant, white with brownish shade.

Starch agar Spreading, growth, becoming brown,

Glucose agar: Restricted, much folded.

brown growth Plainagar: Thin, cream colored growth, becoming gray.

Glucose broth Dense, wrinkled pellicle.

Litmus milk Dark, almost black ring: congulated, with slow pentonization. faintly alkaline reaction.

Potato Brown to almost black growth. Nitrates produced from nitrates Soluble brown pigment formed

Starch is hydrolyzed Acrobic.

Optimum temperature 25°C Source Isolated from soil. Habitat Soil

23. Streptomyces aureus (Waksman and Curtis) comb nov. (Actinomures gureus Waksman and Curtis, Soil Science. I. 1916, 121; not Actinomices ourea Ford. Textb. of Bact , 1927, 220 ) From Latin aureus, colden.

Mycelium shows numerous spirals. Conidra apherical to aval, 06 to 10 by 0 S to t.4 microns.

Gelatin stab: Fair, eream-colored surface growth, becoming brown, spreading Lauefied.

Synthetic agar. Thin, spreading, color-

less growth. Aerial mycelium thin, gray, powdery, becoming cinnamon drab.

Starch agar: Thin, transparent, spreading growth.

Glucose agar: Spreading, light orange growth, raised center, hyaline margin.

Plain agar · Restricted, gray growth. Glucose broth: Thin, brownish ring; flaky sediment.

Litmus milk: Black ring. No congulation. Peptonization doubtful.

Potato: Abundant, wrinkled, brown growth, becoming black.

Nitrites produced from nitrates. Soluble brown pigment formed.

Starch is bydrolyzed. Acrobic.

Optimum temperature 25°C.

Source: Isolated many times from a variety of soils.

Habitat : Soil.

24. Streptomyces erythrochromogenes (Krniusky) comb nov. (Actinomyces erythrochromogenes Krainsky, Cent f. Bakt., II Abt , 41, 1914, 662; Waksman and Curtis, Soil Science, 1, 1916, 112.) From Greek, producing a red color.

. . L. . a a a miamore long. duble

brown pigment formed. Plain sgar: Brown soluble pigment. White aerial mycellum.

Ca-malate agar Colonies circular, with grayish white margined aerial mycelium. Glucose agar. Red pigment formed.

Starch agar . A soluble rose pigment on old cultures.

Glucose broth: Abundant growth. Floating colonies, later a pelfiele is formed. Brown soluble pigment

mycelium actial Potato: Gray Medium colored black

Nitrates show slight reduction. Weakly diastatic.

No proteolytic enzyme formed. No growth in cellulose.

Aerobic.

Optimum temperature 30°G.

Source: Soil and roots of Alnus (alder). Habitat : Soil.

25. Streptomyces lavendulae (Waksman and Curtis) comb. nov. (Actinomyces lavendulae Waksman and Curtis, Soil Science, 1, 1916, 126.) From M. L., lavender.

Hyphae coarse, branching. close, 5 to 8 microns in diameter. Conida oval, 1.0 to 12 by 16 to 20 merons Gelatin stab: Creamy to brownish surface growth. Liquefied.

Synthetic agar: Thin, spreading, colorless growth. Acrial mycelium cottony, white, becoming vinous lavender.

Starch agar: Restricted, glistening, transparent growth.

Plain agar · Gray, wrinkled growth. Glucose broth; Abundant, flaky sediment.

Litmus milk: Cream-colored ring. No coagulation; pentonized, with strong alkaline reaction.

Potato: Thin, wrinkled, cream colored to yellowish growth.

Nitrites produced from nitrates. Soluble brown pigment formed. Starch is hydrolyzed.

Aerobic.

Optimum temperature 37°C.

Certain strains of this organism produce antibiotics. One such antibiotic, designated as streptothricin, is active both in vitro and in vivo against various Gram-positive and Gram-negative bacteria, fungi and actinomycetes (Waksman and Woodruff, Proc. Soc. Exp. Biol Med., 49, 1942, 207; Waksman, Jour Bact., 46, 1943, 299).

Source · Isolated once from orchard soil Habitat: Soil.

26 Streptomyces reticuli (Wakaman and Curtis) comb. nov. (Actinomyces reticuli Waksman and Curtis, Soil Science, 1, 1916, 118.) From Latin reticulum, a amail net.

Mycelium in whorls; spirals formed on

glucose agar are sinistrorse. Conidia spherical, 10 to 1.4 microns in diameter. Gelatin stab: Liquefied with amall,

brown flakes.

Synthetic agar: Colorless growth, with yellowish tinge, becoming brownish, spreading Aerial mycelium thin, white, cottony.

Starch agar: Brownish-gray growth.

Glucose agar: Restricted, brownish growth, center raised

Plain agar. Gray, wrinkled growth, becoming brownish.

Glucose broth Sediment consisting of large colonies.

Litmus milk Reaction unchanged; coagulated, peptonized.

Potato: Gray growth, with black center

37-4-1

Nitrites produced from nitrates Dark brown pigment formed Starch is hydrolyzed.

Aerobie.

Optimum temperature 25°C, Source From upland and schobe soils in California

Habitat : Soil

27 Streptomyces rubriteticuli nom nov (Actinomyces reticulus-ruber Waksman, Soil Science, 8, 1919, 146; Actinomyces reticulus Bergey et al., Manual, 2nd ed., 1925, 373) From Latin ruber, red and reticulum, a small net

Branching filaments with both primary and secondary whorl formation. Spirals formed on glucose sgar. Conidia ovalshaped Gelatin stab: Surface growth yellow-

ish-red to dragon-pink. Liquefied Synthetic agar: Abundant, spreading

Synthetic agar: Abundant, spreading growth, usually pink. Aerial mycelium thin, rise to pink.

Starch agar White growth with red

Glucose agar: Abundant, spreading, rese-red, entire growth.

Plain agar Red growth, with yellowish margin, becoming red.

Glucose broth . Thin, flaky sediment

Litmus milk: Abundant, red pellicle; congulated; peptonized. Reaction unchanged.

Potato: Cream-colored growth, later pink to dark red.

Nitrates produced from nitrates.
Soluble dark brown pigment formed
Starch is hydrolyzed.
Aerobic

Certain strains of this organism produce an antibiotic

Source: Isolated from New Jersey orchard and California upland soils. Optimum temperature 37°C.

Habitat Soil.

28 Streptomyces flavus (Krainsky) comb nov (Actinomyces flavus Krainsky) comb in Actinomyces flavus Krainsky, Cent f Balt, JI Abt, 41, 1914, 662; Waksman and Curtis, Soil Science, 1, 1916, 118; not Actinomyces flavus Sanleince, Cent. f Balt., I Abt., Orig, 33, 1903, 359) From Latin flavus, yellow

Coarse filaments with branching hyphae Conidia formed by building and breaking up of hyphae into oval lorms

Gelatin atab Small, yellowish masses on surface of liquefied medium. Synthetic agar, Circular, yellow or sul-

fur-yellow colonies Aerial mycchum straw-yellow.

Starch agar Spreading, cream-colored growth, with pink tinge. Glucose agar Restricted, mised, lolded,

sulfur-yellow growth, center shading to brown Plain agar Gray, spreading, lolded

growth

Glucose broth Small, white colonies in bottom of tube Litmus milk Congulated, peptonized,

becoming distinctly alkaline.

Potato Elevated, much wrinkled.

greenish-olive growth

Traces of pitrate formed

Soluble brown pigment formed Starch is hydrolyzed

Aerobie

Optimum temperature 25°C. Habitat: Soil.

29. Streptomyces ruber (Krainsky) comb. nov. (Actinomyces ruber Kminsky, Cent. f. Bakt., II Abt., \$41, 1914, 662; Waksman, Soil Science, \$, 1919, 1949, not Actinomyces ruber Sanfelice, Cent. f. Bakt., I Abt., Orig., \$67, 1904, 355; Nocardia kranskii Chalmers and Christopherson, Ann. Trop. Med. and Parasit., \$10, 1916, 203.) From Latin ruber, red

Straight, branching mycelium, radiating. A few spirals may be formed.

Gelatin stab . Liquefaction, with yellow flakes.

Synthetic agar: Abundant, spreading, red growth. Aerial mycelium abundant, cottony, chrome-orange.

Starch agar: Abuudant, spreading, red growth.

Glucose agar: Restricted, abundant, entire, coral-red growth.

Plain agar: Restricted, clevated, wrinkled, clive-green growth.

kled, olive-green growth.

Glucose broth: Red ring, with spongy colonies on the surface.

Litmus milk: Dark ring with red tinge; congulated; peptonized, with alkaline reaction.

Potato: Elevated, wrinkled, greenish growth.

Nitrites produced from nitrates. Soluble brown pigment formed. Starch is hydrolyzed.

Acrobic Optimum temperature 37°C. Habitat: Soil.

30. Streptomyces citreus (Kminsky) comb. nac. (Actinomyces citreus Kninsky, Cent 1. Bakt, 11 Abt, 15, 1914, 62; Waksman and Curtis, Soil Science, 1, 1916, 99; not Actinomyces citreus Gasperini, Cent 1. Bakt., 15, 1894, 684.) From M L citreus, lemon-yellow

Filaments with long, narrow open spirals. Conidia spherical to oval, 12 to 1.5 by 1.2 to 1 8 microns.

Gelatin stab: Yellowish, restricted surface growth. Liquefaction in 35 days.

Synthetic agar: Abundant, spreading, raised, wrinkled, citron-yellow growth. Aerial myceluum covering surface; citronvellow.

Starch agar: Abundant, yellowishgreen growth.

Glucose agar: Extensive, glossy, obreyellow, entire growth; center elevated. Plain agar: Restricted, cream-colored

growth.

Glucose broth; Thin, wide, yellow ring; flaky sediment. Litmus milk: Cream-colored swist

growth; coagulated; peptonized, becoming alkaline
Potato: Yellowish growth, aerisl my-

celium white.

Trace of nitrite production from ni-

Trace of nitrite production from m

The pigment formed is not soluble. Starch hydrolyzed.

Aerobic.

Optimum temperature 37°C. Habitat: Soil.

31. Streptomyces fulvissimus (Jensen)
comb. nov. (Actinomyces fulusimus
Jensen, Soil Science, 50, 1930, 66.) From
Latin fulvissimus, very yellow.

Vegetative mycelium without any special characteristics aerial mycelium of short, straight, offica trilureated hyphas, 1.0 to 1.2 microns broad; no spiral formation; branches of hyphase break up infoconidia, 1.0 to 1.2 by 1.2 to 1.5 micross.

Gelatin: Vegetative mycelium narow, smooth, yellowish-brown to red-brown; no aerial mycelium; no pigment; gelatia completely liquefied in 10 to 12 days.

Nutrientsgar: Good growth; vegetatire mycollum raised, finely wrinkled, deep red-brown; no zerisl mycelium; brownishyellow pigment.

Czapek sugar: Good growth (one strain very scant), vegetative mycelium fist, narrow, first light golden, later deep orange to red-brown; aerial mycelium scant, sometimes almost absent, first white, later light grayish-brown; pigment very characteristic, bright golden to

orange.

Glycerol agar: Good growth; vegetative mycelium narrow, raised, smooth, colden to dark bronze; aerial mycelium scant, in patches, white to light cinnamon-brown; pigment intensely golden to orange.

Starch-casein agar : Good growth : vegetative mycelium apreading, folded, yellowish-brown; aerial mycelium abundant, smooth, lead-gray; pigment dull yellow to orange.

Potate: Good growth; vegetative mycellum raised, much wrinkled, rustbrown; aerial mycelium absent or traces of white; nigment gray to faint lemonvellow.

Locffler's blood serum: Vegetative mycelium red-brown; no acrial mycelium; yellowish pigment; no liquefaction.

Distinctlyo characters: The characteristic golden pigment is formed in nearly all media in which the organism grows, but becomes most typical and attains its greatest brightness in synthetic agar media; it has indicator properties, turning red in strongly acid solutions. The species is easily recognized on near plates by its bronze-colored colonies, surrounded by haloes of bright yellow pigment.

Source: Very common in Danish soils Habitat : Soil.

32 Streptomyces gougeroti (Duché) comb. nov. (Actinomuces goungrati Duché, Eucyclopédic Mycologique, Paris, 6, 1934, 272.) Named for Prof. Gougerot. from whom the culture was obtained.

Gelatin: Cream-colored colonies developing slowly with faint aerial myeelium; no pigment; liquefaction.

Plain agar : Cream-colored growth forming concentric ring with age, with brownish reverse; faint yellowish soluble pigment

Synthetic agar: Slow growth as punctiform colonies; cream colored with smooth

edge; no aerial mycelium; no soluble pigment.

Peptone broth: Gream-colored ring on surface of medium with flakes throughout the medium; no soluble pigment.

Synthetic solution: Submerged mycelium in the form of flakes, later forming a surface pelliele; filaments of aerial mycelium I micron in diameter, with numerous conidia; eream-colored growth; no soluble pigment

Tyrosine medium: Good growth with white acrial myeclium; no soluble pigment.

Litmus milk: Growth in the form of colonies which remain separated from one

another; also flakes in the bottom of the tube with bluish tinge on reverse of growth: milk turns blue in 10 to 12 days. Congulated scrum; Cream-colored

growth covered with white serial mycelium; rapid liquefaction of scrum.

Potato : Slow growth of a greenish tinge; aerial mycelium; no black plgment.

Distinctive character: Intermediate between Streptomyces albus with Ita abundant aetial mycelium and Actinomuces almquisti with its very scanty aerial mycelium

Source Culture obtained from the collection of Prof. Gougerot.

33 Streptomyces violaceoniger (Waksman and Curtis) comb. nor (Actino. muces crofaceus-niger Waksman and Curtis, Soil Science, 1, 1916, 111 ) From Latin erofaceur, violet and niger, black.

Gelatin. Gray growth, with no production of acrial mycelium Gelatin around colony rapidly liquefied, but without any change in color.

Czuock's agar. Colony at first dark gray, turning almost black, 2 to 4 mm in diameter. Surface glossy, much folded with a very thin gray margin. A white to gray acrist mycelium is produced after the colony has well developed. A bluishblack pigment is produced at a later stage of its growth. The pigment slowly dis. solves in the medium, turning almost black. Odor fairly strong. Microscopically two types of mycelium are found: the thin, branching flaments of the substratum, and the thick filaments of the aerial mycelium. The aerial mycelium fragments not very rapidly, producing a few conidia, spherical and oval, 1.2 to 1.5 by 1.2 to 2.3 microns. These often occur in chains.

Czapek's solution: Colonies large, 2 to 3 mm in diameter, appearing at the bottom and surface of the solution, but none throughout the medium. Colonies bluish in color, with a regular margin. Medium not colored

Potato plug: Crowth at first very slight, but after 48 hours develops into a yellowish-gray continuous thick smear which lator turns brown, with a white aerisl mycellum covering the growth. Medium not colored.

Source. Isolated once from the upland California soil

Habitat : Soil.

34. Streptomyces griseus (Krainsky) comb. nov. (Actinomyces griseus Krainsky, Cent. f Bakt, II Abt., 41, 1914, 662, From M L. griseus, gray.

Branching filaments; a few spirals have been observed. Conidia rod-shaped to short cylindrical, 0 8 by 0.8 to 17 microns. Aerial mycelium greenish-gray

Gelatin stab · Greenish-yellow or creamcolored surface growth with brownish tinge. Rapid liquefaction

Synthetic agar 'Thin, colorless, spreading growth, becoming ohre buff. Aeral mycelium thick, powdery, water-green

mycelium thick, powdery, water-green Starch agar Thin, spreading, trans-

parent growth.

Glucose agar: Growth elevated in center, radiate, cream-colored to orange,

erose margin
Plain agar Abundant, cream-colored,
almost transparent growth.

Glucose broth Abundant, yellowish pellicle with greenish tinge, much folded. Litmus milk. Cream-colored ring; coagulated with rapid peptonization, becoming alkaline.

Potato: Yeliowish, wrinkled growth. Nitrites produced from nitrates.

The pigment formed is not soluble. Starch is hydrolyzed. Aerobic.

Optimum temperature 37°C.

Different strains of this organism produce different antibiotics. One of thes, streptamycia, was isolated in crystalize form. It is active against a large number of bacteria and actinomycetes, but not against fungi and viruses. It is not very toxic to animals, and has found extensive application in the treatment of various diseases, mostly caused by Gram-negative bacteria and certain forms of the proculosis.

Source: Garden soil. Habitat: Soil.

35. Streptomyces griseoffarus (Krsinsky) comb. nov. (Actinomyces griteoffarus Krainsky, Cent. f. Bakt., II Abt., 41, 1914, 662.) From M. L. griseus, gwand Latin flatus, yellow.

Conidia oval, 1 2 microns.

Gelatin colonies : Yellowish. Concentric

Gelatin stab: Rapidly liquebed.
Plain sgar: Colonies yellowish, with
white aerial mycelium.

Ca-malate agar: Large colonies covered with yellow to greenish-gray aerial mycellium

Glucose agar . White acrial mycelium is slowly formed.

celum gray.

Nitrites produced from nitrates.

Weakly dustatie. Acts on esculin.

Grows well on cellulose.

Aerobic

nr.

Optimum temperature 35°C. Habitat. Scil

36. Streptomyces albidoffavus (Rossi Doria) comb. nov. (Streptotrix (sic) albido flara Rossi Dona, Ann. d. Ist. d'lg, sper, d. Univ. di Roma, 1, 1891. 407: Actinomyces albido-flavus Gasperini, ibid , 2, 1892, 222; Streptothrix albido Chester, Man Determ, Bact . 1901, 365; Cladothrix albido-flava Macé, Traité Pratique de Bact., 4th ed., 1901, 1097; Nocardia albida Chalmers and Christopherson, Ann. Trop, Med. and Parasit , 10, 1916, 271.) From Latin albidus, white and flatus, yellow.

Description from Duche, Encyclopédie Mycologique, Paris, 6, 1934, 294 Gelatin Punctiform colonics with

white aerial mycelium on surface of hourd, no soluble pigment; rapid houefaction.

Synthetic asparagine agar: Growth becomes rapidly covered with white aerial mycelium, later becoming whitishvellow: brown on reverse side: vellowish soluble pigment

Pentone agar: Cream-colored growth covered with fine white acrual mycelium. vellow soluble pigment.

Tyrosine agar. Fine growth with orango-vellow on reverse side, medium becomes colored vellowish to vellowish-1058

Synthetic asparagine solution: Long branching filaments, 06 micron in diameter Thicker aerial mycelium producing irregular spores; flaky growth dropping to bottom of tube Surface growth becomes covered with vellowishwhite acrial mycelium; brownish on reverse side, soluble pigment vellowish

Pentone solution Rapid, much folded growth, partly covered with white mycelium on surface of medium; soluble vellow-othre pigment

Milk Rapid growth becoming covered with whitish serial mycelium, never fully covering the surface; no coagulation, pentonization begins slowly and is completed in 13 days, liquid becoming colored vellowish-orange

Congulated scrum. Cream-colored growth of surface becoming covered with white serial mycelium : rapid liquelection of serum.

Starch medium. Cream-colored growth rapidly colored with yellow aerial mycelium : after 20 days growth becomes much folded: greenish on reverse side: slightly amber color in medium

This strain is closely related to Strepto. muces albus. Develops poorly on

Czapek's medium without asparagine. Source: From dust.

37. Streptomyces poolensls (Taubenhaus) comb nov. (Actinomyces poolensis Taubenhaus, Jour Agr. Res. 15. 1918, 416 ) Named for Prol. R. F. Poole. plant pathologist

Description from Walsman, Soil Sei, 8, 1919, 140

Fine, branching mycchium; spirals usually not seen. Conidia oval to elliptical

Gelatin stab Liquefied, with small, brownish flakes in fluid

Synthetic agar Thin, colorless, spreading growth Aerial mycelium white to

Starch agar. Restricted, cream-colored growth.

Glucose agar. Growth abundant, light brown, glossy, raised center, entire.

Plain agar Yellowish, translucent growth.

Glucose broth . Thin, brownish ring. Litmus milk. Brownish ring; coagulated: peptonized, with strongly alkaline

Potato Thin, reddish-brown; medium becoming purplish.

Nitrates produced from mitrates.

Faint trace of soluble brown pigment. Starch not hydrolyzed.

Aerobic.

reaction

Optimum temperature 37°C. Associated with disease of Source sweet potato.

38. Streptomyces ollvaceus (Waksman) comb. nov. (Actinomyces 206, Waksman, Soil Science, 7, 1919, 117: Actinomyces olivaceus Waksman, in Manual, 1st ed., 1923, 354.) From Latin. olive-colored.

Small clumps, with straight and branching hyphae. No spirals on most media. Conidia spherical and oval, 0.9 to 1.1 by 0.9 to 20 microns.

Gelatin stab: Liquefied with creamcolored, flaky, yellow pediment.

Synthetic ngar: Growth abundant. spreading, developing deep into medium, rellow to olive-ochre, reverse yellow to nlmost black. Acrial mycelium mousegray to light drab.

Starch agar: Thin, yellowish-green,

spreading growth.

Glucoso agar: Growth abundant, reatricted, entire, center raised.

Plain agar: White, glistening growth. Glucoso broth: Sulfur-vellow ring.

Litmus milk: Faint, pinkish growth; coagulated; peptonized, becoming alkaline.

Potato: Growth abundant, much wrinkled, clevated, gray, turning sulfuryellow on edge.

Natrites produced from nitrates. The pigment formed is not soluble.

Starch is hydrolyzed.

Aerobic.

Optimum temperature 25°C.

Habitat: Soil.

lieskei (Duché) 39. Streptomyces comb. nov. (Actinomyces lieskei Duché, Encyclopédie Mycologique, Paris, 6, 1934, 289.) Named for Prof. Lieske of Leipzig.

Gelatin: Cream-colored growth becoming covered with white aerial mycelium; no soluble pigment. Rapid liquefaction.

Plain agar: Cream-colored growth becoming covered with white aerial mycelium; yellowish soluble pigment.

Synthetic agar: Cream-colored growth with delayed white aerial mycelium growing from the edge toward the center; mycelium later yellowish. Reverse of growth yellowish to green. Dirty yellow to yellow-green soluble pigment.

Synthetic solution: Long branching filaments 0.7 micron in dismeter. Yellowish-white nerial mycelium does not readily produce spores; flakes drop to the bottom of the tube.

Pentone solution: Cream-colored colonies on surface with flakes in the hquid dropping to the bottom of the tube. Liquid becomes vellowish in color.

Tyrosine medium: Rapid growth on nurface with whitish-yellow aerial mycelium; yellowish to orange yellow soluble pigment.

Milk: Cream-colored growth; colorless on reverse side: no aerial mycelium. Pentonization without congulation. After 20 days the whole milk becomes a clear yellowish liquid.

Clear-colored Coarulated serum: growth. Rapid liquefaction.

Culture related to Streptomyces alboflavus and Streptomyecs albidoflavus.

40. Streptomyces microflayus (Krainnky) comb. nov. (Actinomyces microflavus Krainsky, Cent. f. Bakt., II Abt, 41, 1914, 662; Micromonospora microfiato Encyclopedie Mycologique, Duché. Paris, 6, 1931, 29.) From Greek micrus, small, and Latin flavus, yellow.

Conidia large, spherical to rod-shaped, often in pairs or chains, 2.0 by 20 to 50

microns.

Gelatin colonies: Small, yellow Gelatin stab: Liquefied.

Plain agar: Yellow colonies, with roseyellow acrial mycelium in 3 to 4 weeks. Ca-malate agar: Minute yellow colo-

No zerial mycelium. Glucose agar: A rose-yellow aerial mycelium develops in about 12 days.

Starch agar: Same as on glucose ager Glucose broth: Small spherical colonies in depth.

Litmus milk: Peptonized. Potato: Yellow growth. No acrisl mycelium

Nitrites produced from nitrates.

Strongly disstatic. Scant growth on cellulose. Starch is hydrolyzed.

Aerobic

Ontimum temperature 25°C Habitat : Soil.

41 Streptomyces cacaol (Waksman) comb. nov. (Actinomuces cacaoi Waksman, in Bunting, Ann. Appl. Biol., 19. 1932, 515.) Named for the chocolate tree (Theobroma cacao).

Long scrial myeelium with considerable spiral formation; the spirals are long and

onen, not compact.

Gelatin Flocculent growth. No acrial mycelium. Rapid liquefaction. No pigment production.

Nutrient agar · Brown-colored growth covered with tiny patches of ivery-

colored aerial mycelium.

Glucose agar: Thin yellowish growth, later turning reddish-brown; no soluble pigment; light gray to mouse-gray mycehum, with white edge. Typical odor of streptomyces.

Czanek's agar : Samo as on glucose agar. Potato · Abundant brownish growth with white to mouse-gray agrisl mycelium.

Biochemical characteristics: Strong protectivitie enzymes acting on easein and gelatin; strong diastatic action, no sugar or dextrin left in 1 per cent starch solution after a few days. Limited reduction of nitrate.

Source: Three strains isolated from cacao beans in Nigeria. There were slight differences among the three strains; the above description is of Strain I.

42. Streptomyces novaecaesareae nom nor (Actinomyces riolaceus-caesers Walaman and Curtis, Soil Science, 1, 1916, 111.) From Nora Caesarea, Latin name for the State of New Jersey.

l'ilamenta with both straight and spiral serial hyphae; spirals dextrorse. Conidia oval to clongate.

Gelatin stab : Small, cream-colored surface colonies with atow liquefaction.

Synthetic agar : Growth gray, becoming bluish, glossy, raueb wrinkled. Aerial mycelium specara late: white.

Starch agar: Restricted, circular, blueish-violet colonies.

Glucose agar: Restricted, gray growth, beroming red.

Plain sear: Thin, cream-colored growth.

Glucose broth: Fine, colorless, flaky acdiment.

Litmus milk: Grav ring, coagulated: alow peptonization, becoming faintly alkalipe

Potato: Gmath eresm-colored.

wrinkled, turning yellowish.

Nitrites produced from nitrates. Soluble purple pigment formed.

Starch is hydrolyzed. Aembie.

Optimum temperature 37°C. Source. Isolated once from upland California soil.

Habitat · Soil

43. Streptomyces exfoliatus (Waksman and Curtis) comb. nov. (Actinomuces exfoliatus Waksman and Curtis. Soil Science, J. 1916, 116 ) From Latin, stripped of foliage

Slightly navy filaments with tendency to form spirals Conidia oval, 1.0 to 15 by 1.2 to t 8 microns.

Gelatin stah. Cream-colored surface growth. Liquefied

Synthetic sgar Growth colorless, becoming brown, smooth, glossy, Aerial myeelium in white ratches over surface. Starch agar Restricted, gray growth,

beroming brown. Plain agar: Grows only in depth of medium.

Glueree broth. Small, grayish colonies In depth.

Litmus milk: Cream-colored ring, soft coagulum in 12 days; slow peptonization, becoming strongly atkaline.

Potato: Growth somewhat wrinkled, gray, becoming brown.

Nitratra produced from nitrates. Brown, soluble pigment formed.

Starch is hydrolyzed.

Aerobic.

Optimum temperature 37°C.

Source: Isolated several times from adobe and upland soils in California. Habitat: Soil

44. Streptomyces gelaticus (Waksman) comb. nov. (Actinomyces 104, Waksman, Soil Science, & 1919, 165; Actinomyces gelaticus Waksman, in Manual, 1st ed. 1923, 356.) From M. L. gelaticus, gelatinous.

Branching mycelium with open spirals. Gelatin stab: Liquefied with cream-

colored flaky sediment.

Synthetic agar: Growth colorless, spreading, chiefly deep into the medium. Aerial mycelium thin, white, turning grayish

Starch agar: Thin, spreading, cream-

colored growth.

Glucose agar: Abundant, spreading, white growth

Plain agar: Wrinkled, cream-colored growth only on the surface.

Glucose broth Thin, cream-colored pellicle; slight flaky sediment.

Litmus milk Pinkish ring, coagulated; peptonized with distinctly alkaline reaction Potato: Growth abundant, much

wrinkled, greenish, becoming black with yellowish margin Nitrates show slight reduction to its

trites
Soluble brown pigment formed.

Soluble brown pigmen Starch is hydrolyzed.

Aerobic.

Optimum temperature 25°C.

Habitat · Soil

45. Streptomyces rutgersensis (Waksnan and Curtis) comb. nov. (Achanmyces rutgersensis Waksman and Curtinorutgers (November 1916, 123.) Named (Is, Rutgers University, New Brunswick, New Jersey

Branching filaments with abundant open and closed spirals; hyphae fine, long, branching Conidia spherical and oval, 1.0 to 1.2 microns, with tendency to bipolar staining.

Gelatin stab: Cream-colored, spreading surface growth. Liquefied.

Synthetic agar: Growth thin, colorless, spreading, hecoming hrownish to almost black. Aerial mycelium thin, white, becoming dull-gray.

Starch agar: Gray, spreading growth.

Glucose agar · Abundant, brown mycelium, becoming black with cream-colored margin.

Plain agar: Thin, wrinkled, creamcolored growth. Litmus milk: Cream-colored ring,

coagulated; slow peptonization, becoming alkaline.

Potato: Abundant, white-gray, much folded growth.

Nitrites produced from nitrates. The pigment formed is not soluble. Starch is hydrolyzed.

Acrobie.

Optimum temperature 37°C.

Source: Isolated many times from a variety of soils.

Hahitat: Common in soil.

46. Streptziyces lipmanii (wathina and Curtis) comb. nov. (Actinomyce ilpmanii Waksman and Curtis, Sal Science, 1, 1916, 123.) Named for Prof. J. G. Lipman, New Jersey Agricultural Experiment Station.

Straight, branching mycelium and hyphae. Conidia oval, 0.8 to 1.1 by 10

to 15 microns.

Gelatin stab: Liquefied with cream-

colored, flaky sediment.

Synthetic agar: Growth abundant,

Synthetic agar: Glovid light brown raised, colorless, becoming light brown and wrinkled. Aerial mycelium whit, turning gray.

Starch agar: Transparent growth, be

coming dark with age.
Glucose agar: Light yellow, irregular,

spreading growth
Plain agar: Yellow, glossy, radiately

wrinkled growth.
Glucose broth: White ring, with shundant, colorless flaky sediment Litmus milk: Cream-colored ring; coagulated, peptonization with alkaline reaction.

Potato: Abundant, eream-colored, wrinkled growth.

Nitrites produced from nitrates

The pigment formed is not soluble Starch is hydrolyzed.

Aerobic.

Optimum temperature 25°C.

Source Isolsted many times from a variety of soils.

Habitat: Common in soil.

47 Streptomyces halstedil (Waksman and Curtis) comb. nov. (Actinomyces halstedi: Waksman and Curtis, Soil Science, 1, 1916, 124) Named for a person.

Branching mycelium and hyphae with close spirals Conidia oval or rodshaped, 1 0 to 1 2 by 1.2 to 1 8 microns Gelaim stab. Liquefied, with small.

eream-colored masses in bottom of tube. Synthetic agur. Growth abundant, heavy, spreading, rsised, light, becoming dark, almost black Aerial myechum white, turning dull-gray.

Starch agar Abundant, brownish, glossy growth

Glucose sgar Growth spreading, colorless, wrinkled, center elevated, edge lichenoid, becoming brown.

Plan agar Restricted, wrinkled, cream-colored growth.

Glucose broth Small, colorless colonies in bottom of tube

Litmus milk. Cream-colored ring, coagulated, peptonized, becoming alkaline Potato Growth abundant, most, wrinkled, cream-colored with green tinge

Nitrites produced from nitrates
The pigment formed is not soluble.

Starch is hydrolyzed. Ontimum temperature 37°C

Aerobic.
Source: leolated many times from the

deeper soil layers.

48. Streptomyces hygroscopicus (Jen-

sen) comb. nov. (Actinomyces hygroscopicus Jensen, Proc. Linn. Soc New So. Wales, 56, 1931, 257.) From Greck, hygroscopic.

Hyphae of vegetative mycelium 0 6 to 08 meron in diameter. Aerial hyphae long, tangled, branched, 0 8 to 10 mieron in diameter; apirals numerous, sinistrorse, narrow, usually short, only 1 or 2 turns, closed, typically situated as dense clusters on the main stems of the aerial hyphae Condus oval, 0 8 to 10 by 10 to 1.2 mierons.

Gelatin: Slow liquefaction, No pig-

ment produced.

Nutrient agar: Good growth Vegetative mycelium raised, wrinkled, glossy, cream-colored; later yellowish-gray with yellowish-brown reverse. Occasionally a scant white aerial mycelium.

Sucrose agar: Good to abundant growth. Vegetative myeclum heavy, superficially apreading, folded, glossy surface, white to cream-colored, later suffur-yellow to yellowship-gray, with golden to light orange reverse. Soluble pigment of the same color. Aerial myeclum scant, thin, white or absent:

Glucese agar. Good growth. Vegetative mycelium superfeially apreading, surface granulated, cream-colored to straw-yellow, later dall chrome-yellow to brownish-orange. Aerisi mycelium thin, smooth, dustry, white to pale yellowishgray, after 1 or 2 weeks more or less abundantly interspersed with small, most, dark violet-gray to brownish patches which gradually spread over the whole surface. Light yellow soluble mement

Potato Fair growth Vegetative mycelium raised, wrinkled, eream-colored, later yellowish gray to dull brownish. Aerial myrelium alsent or trace of white.

Milk Completely digested in 3 to 4 weeks at 30°C without any previous coagulation. The reaction becomes faintly

acid (p1160 or less)

Nitrates not reduced with sucrose as source of energy

Sucree is inverted.

Starch is hydrolyzed.

Cellulose is decomposed readily by some strains.

Distinctive character: In this species. the aerial mycelium (which in other actinomycetes is strikingly hydrophobic) on certain media (glucose or glycerol asparagine agar) becomes moistened and exhibits dark, glistening patches. These patches, when touched with a needle. prove to be a moist, smeary mass of spores. This characteristic feature is not countly distinct in all strains.

Source: Seven strains isolated from snila.

Habitat : Soil.

49. Streptomyces fradiae (Waksman and Curtis) comb. nos. (Actinomyces fradii Waksman and Curtis, Soil Science, 1, 1910, 123 ) From the name of a person.

Straight, branching filaments and byphag. No spirals. Conidis rod- or ovalshaped, 0.5 by 0.7 to 1.25 microns.

Gelatin stab: Cream-colored to brownish, dense growth on liquid medium.

Synthetic agar: Smooth, spreading, colorless growth. Aerial mycelium thick, cottony mass covering surface, sea-shell pink

Starch agar: Spreading, colorless growth.

Glucose agar: Growth restricted, glossy, buff-colored, lichenoid margin.

Plain agar Growth yellowish, becoming orange-vellow, restricted

Glucose broth: Dense, narrow, orange-

colored ring; abundant, flaky, colorless sediment. Litmus milk: Faint, cream-colored

ring; coagulated; peptonized, becoming alkaline. Restricted, orange-colored

Potato. growth

Nitrites not produced from nitrates. The pigment formed is not soluble. Starch is hydrolyzed.

Aerobic.

Optimum temperature 25°C.

Source: Isolated once from adobe soil in California.

Habitat: Soil.

50. Streptomyces alboflarus (Walsman and Curtis) comb. nov. (Actinomyces alboflavus Waksman and Curtis, Soil Science, 1, 1916, 120 ) From Latin albus, white and flavus, yellow.

Straight, branching mycelium, with very little tendency to form spirals Very few oval-shaped conidia formed.

Gelatin stab: Abundant, colorless surface growth. Liquefaction occurs in 35 days.

Synthetic agar: Growth glossy, colorless, spreading, becoming yellowish Aerial mycelium white, pondery, with vellow tinge.

Starch agar: Thin, yellowish, spreading growth.

Gluense agar: Growth restricted,

much-folded, creamy with sulfur-yellow surface.

Plain agar: Restricted, cream-colored growth.

Glucose broth: White, cylindrical colonies on surface, later flaky mass in bottom of tube.

Litmus milk · Pinkish ring. No congulation. Peptonized, becoming alkaline. Potato: Moist, cream colored, wrighted

growth. Nitrites produced from nitrates.

The pigment formed is not soluble. Starch is hydrolyzed

Aerobic.

Optimum temperature 37°C. Source: Isolated once from orchard soil

Habitat: Soil.

 Streptomyces albosporeus (Krainsky) comb. nov. (Actinomyces albosporeus Krainsky, Cent. f. Bakt, II Abt , 41, 1914, 649; Nocardia albosporea Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 269; Waksman and Curtis, Soil Science, 1, 1916, 99.) From Latin albus, white and Greek spora, spore.

Straight, branching filaments with straight, branching hyphae, and occasional spirals. Conidia spherical or oval, 0 8 to 1.2 hy 1.0 to 1.8 microns.

Gelatin atab: Growth yellow, changing to red, with hyaline margin Liquefaction in 35 days.

Synthetic agar: Growth spreading, colorless with pink center, becoming brownish. Aerial mycelium white at

first, later covering the aurface
Starch agar: Growth thin, apreading,
transparent, with red tinge.

Giucose agar: Growth spreading, red, wrinkled, radiate, entire.

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Plain agar: Minute, cream-colored colonics.

Glucose broth: Pinkish ring. Litmus milk: Scant, pink ring. No

congulation No peptonization.

Potato: Growth thin, spreading, wein-

kled, gray, becoming brown with greenish tinge.

Natrites produced from nitrates.

The pigment formed is not soluble.

Starch is hydrolyzed.
Aerobic.

Optimum temperature 37°C. Habitat: Soil.

52. Streptomyces flocusius (Duché) comb nos. (Actinomyces flocusius Duché, Encyclopédie Mycologique, Paris, 6, 1934, 300.) From Latin, somewhat woully, referring to the appearance of the aerial mycelium.

Gelatin Very limited growth. Slow liquefaction

Asparagine gluces agar: Weak growth; limited cream-colored colonies hardly raised above the surface of the medium; occasionally abundant growth is produced with white aerial mycelium and coloriess on reverse side.

Czapek's agir. Cream-colored growth, later covered with white aerial mycelium; no soluble pigment.

Peptone agar Cream-colored growth, later covered with white serial mycellium; no soluble pignient. Asparagine glucose solution: Branching immersed filaments, 08 micron in dameter; acrisl mycelium 1.0 by 1.2 raierons with numerous conida; flakes settle to the bottom of the tube.

Peptone solution: Pointed colonies; cresm-colored on surface of medium.

Tyrosine medium: Whitish growth without any pigment.

Milk Rose-colored growth; slow peptonization.

Potato: Punctiform growth covered with white aerial mycelium; faint yellow-

ish pigment.

Coagulated serum: Cream-colored growth; fine white serial mycelium; slow haucfaction of serum

Source. Culture obtained from Mr. Malençon, an inspector in Moroeco.

53 Streptomyces melanosporeus (Arainsky) comb. nov (Alctinomyces melanosporeus Krainsky, Cent f. Bakt., II Abt., 41, 1914, 162; Nocardia melanospora Chalmers and Christopherson, Ann Trop Med. and Parasit, 10, 1016, 265) From Greek melas, black and spora, spore

Conidia almost spherical, 12 microns in diameter.

Gelatin colony Small, reddish colo-

Gelatin stab. Liquefied.

Ca-malate agar. Colonies red, with black aerial mycelium.

Glucose agar. Same as on Ca-malate agar. Starch agar: Same as on Ca-malate

sgar.
Glucose broth Flaky, orange-red colo-

Glucose broth Flaky, orange-red colonies adherent to glass

Litmus milk, Peptonized.

Potato: Red rolonies with black aerial mycelium.

Natrates produced from nitrates. Weakly disstatic.

Grows well on cellulose. Cellulose is

decomposed Aerobic Optimum temperature 25°C. Habitat: Soil.

51. Streptomyces melanocyclus (Merher) comb. nov. (Micrococcus melanocyclus Merker, Cent. f Bakt., II Abt., SI. 1911, 589; Actinomyces melanocyclus Krainsky, Cent f. Bakt., II Abt., 41, 1914, 662; Nocardia melanocycla Chalmers and Christopherson, Ann. Trop. Med, and Parasit., 10, 1916, 268.) From Greek melas, black and cuclus, circle.

Conidia almost spherical, 09 micron in diameter.

Gelatin colonies: Growth poor.

Gelatin stab: Rapid liquefaction.

Ca-malate agar; Colonies small, flat, orange-red. Aerial mycelium black, occurring along the edges.

Glucose broth; Same as on Ca-malate agar.

Starchngar · Same as on Ca-malate agar. Glucose broth: Colorless, spherical colonies

Litmus milk: Peptonized.

Nitrites produced from nitrates.

Good diastatic action. Cellulose is decomposed

Aerobic. Optimum temperature 25°C.

Habitat Soil

55 Streptomyces acidophilus (Jensen) comb. nov. (Actinomyces acsdophilus Jensen, Soil Sci., 25, 1928, 226 ) From Greek, acid-loving.

myeelium profusely Vegetative branched, hyphae 06 to 0.8 micron in diameter with homogeneous protoplasm and no visible septa. Aerial mycelium with hyphae 10 to 1.2 microns in diameter, somewhat branched, forming either very few or very numerous sinistrorse spirals Oval conidia 1.0 to 12 by 1.2 to 1.5 microns.

Gelatin: After 10 days growth very scant, thin, colorless, semi-transparent Slow liquefaction.

Nutrient agar: No growth

Glucose agar: Good growth at 25°C Substratum mycelium raised, somewhat wrinkled, colorless in young culture Aerial mycelium thin, white at first later gray or yellowish-brown.

Starch sgar: Good growth at 25°C. Substratum mycelium flat, smooth, colorless. Aerial mycelium smooth, white.

Czapek's agar : No growth Plain broth: No growth.

Milk: No growth.

Petato: Growth good, raised, felded Na discoloration.

Nitrites not produced from mintes except a trace in tuo strains.

Diastatic.

Weakly proteolytic.

Inversion of sucrose: Negative. Distinctive character: The ability to

live in acid media only. Source: Four strains isolated from three acid humus soils.

Habitat: Acid humus soils.

56. Streptomyces rubescens (Jarach) comb. nov. (Streptothriz rubescens Jameh, Boll. Sez Ital. Soc. Intern. Microb , 1931, 43.) From Latin rubescens, becoming red.

Gelatin: No liquefaction; limited non

pigmented gronth. Glucose agar: Large number of small round colonies raised in the center and growing together, as well as deep into the medium; of a whitish opalescent color.

Gzapek's agar: Poor gronth, becoming pigmented salmon-red, edge entire. Milk agar medium: Rose-coral-colored,

thin growth with edge entire.

Broth: Minute flakes, the liquid later becoming reddish-colored Milk. No congulation and no digestion,

slight red coloration of milk Petato plug: Reddish groath, not ex-

tensive; opalescent surface. Source: From soil,

57. Streptomyces thermophilus (Gilbert) comb. nor. (Actinomyces thermophilus Gilbert, Ztschr. f. Hyg., 47, 1904, 383; not Actinomyces thermophilus Berestnew, Inaug. Diss., Moskow, 1897; Nocardia thermophila Chalmers and Christopherson, Ann. Trop Med. and Parasit., 10, 1916, 271.) From Greek thermus, heat and philus, loving

Description from Waksman, Umbreit and Gordon, Soil Sci , 47, 1939, 49

Hyphae straight, conidia formed

Gelatin · Liquefaction.

Czapek'a agar: At 28°C, deep colorless growth, thin white aerial mycehum; no soluble pigment.

Starch agar: Yellowish growth with white-gray, powdery aerial mycehum.

Milk Proteolysis.

Potato plug: Yellowish growth with no aerial mycelium, the plug usually being colored brown.

Starch is hydrolyzed

No pigment produced on nutrient agar or gelatin

Temperature relations, Optimum 50°C Good growth at 23°C. Usually no growth at 60°C. Some strains are incapable of growing at 28°C, whereas others

seem to grow well even at 65°C Aerobie

Habitat Soil hay, composts

59 Streptomyces thermotuscus (Waksman, Umbreit and Gordon) comb nor. (Actinomyces thermofuscus Waksman, Umbreit and Gordon, Soil Sci. 47, 1939, 49) From Creek thermus, heat and Latin fuscus, dark Presumably derived to mean heat-loving and dark in

Hyphae spiral-shaped; conidia produced

Gelatin: Liquefaction At 50°C, a gray ish ring is produced and soluble nigment is formed At 2S°C, growth with no soluble pigment

Czapek's agar. Poor growth at 28°C. deep gray, with but little acrisl mycehum At 50°C, growth dark to violet, with gray to lavender aerial mycehum and soluble brown pigment.

Mith Proteclysis

Abundant. datk-colored growth, no aerial mycelium, or few white patches, dark soluble pigment

Starch is hydrolyzed.

Temperature relations: Cood growth at 50° and 60°C. Will grow at 65°C. Faint growth at 28°C.

Aerobic.

Distinctive characters: This apecies is diatinguished from Streptomyces thermophilus by the brown-colored aerial mycelium on synthetic media, spiral-shaped hyphae, and ability to grow readily at

Habitat: Soils and composts.

59. Streptomyces scalles (Thaxter) comb nov (Oospora scabies Thanter, Ann. Rept Conn. Agr Evn Sta., 1891. Actinomyces scabies Gussow, Science, N S. 39, 1914, 431.) From Latin scabies, scah.

Wavy or slightly curved mycelium, with long branched aerial hyphae, showing a few apirals. Conidia more or less cylindrical, 0 8 to 1 0 by 12 to 15 mierons

Gelatin atab. Cream-colored surface growth, becoming brown Slow liquefaction

Synthetic agar. Abundant, creamcolored, wrinkled, rassed growth. Aerial macchum white, acaree Starch agar. Thin, transparent, spread-

ing growth Clucose agar Restricted, folded, cream-colored, entire growth.

Plain agar: Circular, entire colonies. amouth, becoming mised, lichenoid, wrinkled, white to atraw-colored, opalescent to oraque.

Glucose broth: Ring in form of small colomes, settling to the bottom

Litmus milk. Brown ring with greenish tinge; congulated; peptonized with alkaline reaction.

Potato: Gray, opalescent growth, becoming black, wrinkled

Nitrites produced from nitrates. Brown soluble pigment formed

Starch is by drolyzed. Optimum temperature 37°C.

Aerobic.

The potato scale organism, like other

acid-fast organisms, can be selectively impregnated with earbol-aucomin and when exposed to ultraviolet radiation fluoresces bright yellow. This technic coolirms Lutman's conclusion that the hyphse are intercellular and grow within the middle lamellae (Richards, Stain Tech., 18, 1943, 91-94).

Source: Isolated from potato scab le-

sions.

Habitat: Cause of potato scab; found in soil.

60. Streptomyces Ipomoea (Person and Martin) comb. nov. (Actinomyces ipomoca Person and Martin, Phytopath., 30, 1910, 313.) From M. L. Ipomoca, a geogric namo.

Conidia on glucoso-casein agar: Oval to elliptical, 0.9 to 1.3 by 1.3 to 1.8 microns.

Gelatin: After 25 days at 20°C, scanty growth, no aerial mycellum; no soluble pigmont: liquefaction.

Synthetic agar: Abundant growth, mostly on surface of medium, moderately wrinkled, blive-yellow.

Nutrient agar: Moderate growth in the form of amall, shiny, crinkled colonies both on the surface and imbedded in the medium, silver-colored.

Starch agar: Growth moderate, smooth, deep in medium, ivory-colored. Aerial mycellum white with patches of bluishgreen. No soluble pigment Complete hydrolysis after 12 days.

Milk: Growth in form of ring; hydrolysis, without visible coagulation.

Potato: Growth moderate, light brown, shiny, wrinkled. No aerial mycelium. No soluble pigment.

Nitrites are produced from nitrates Starch is hydrolyzed.

No growth on cellulose.

Source: From diseased sweet-potato (Ipomoca sp ) tubers and small roulets from several localities in Louisiana.

61. Streptomyces fordil (Erikson) comb. nov. (Actinomyces fordii Erikson, Med. Res. Counc. Spec. Rept. Ser. 203, 1935, 15 and 36.) Presumably named for the surgeon who first secured the culture.

Mycelium: Filaments of medium length, no spirals or markedly wavy branches. Short, straight, sparse aerial mycelium. Small oval conidia on potato agar and starch agar.

Gelatin: No visible growth, slight softening in 20 days; half-liquefied after

40 days.

Agar: Small, creamy-golden, ringshaped colonies, and heaped-up patches, becoming golden-brown in color and convoluted.

Glycerol agar: Extensive, goldenbrown, convoluted, thin layer.

Serum agar: Golden-brown ring-shaped and coiled smooth colonies; no liquefaction.

Ca-agar: Yellow, scale-like closely adherent colonies; scattered white aerial mycellum.

Blood agar: Innumerable small yellowish ring-shaped colonies; no hemolysis.

Broth: Few flakes at first; later abuadant coherent puffball growth.

Synthetic sucrose solution: Moderate sediment of minute round white colonies. Synthetic glycerol solution: Light white fluffy colonies, mioute and in clusters.

Inspissated serum: Innumerable colorless pinpoint colonies; scant white arisk mycelum; after 15 days colonies large, hollow on reverse side; margin depressed; no liquefaction.

Dorsot's egg medium: Minute, creamcolored, elevated colonies, becoming golden-brown, raised, convoluted.

Milk: Congulated; brownish surface

ing. Litmus milk: No change in reaction.

Potato plug: Yellowish growth in thin line, terminal portion tending to be pied up, scant white aerial mycelium at top of slant; after 12 days, growth abundant, golden-brown, confluent, partly honeycombed, partly piled up.

Starch not hydrolyzed.

Tyrosine agar: Reaction negative. Source: Ruman spleen in a case of acholuric jaundice.

62. Streptomyces africanus (Puper and Pullinger) comb. nov. (Nocardia africana Piper and Pullinger, Jour. Trop. Med. and Hyg., 30, 1927, 153; Actinomyces africanus Nannizzi, in Pollaci, Tratt. Micopat. Umana, 4, 1934, 8) From Latin Africanus, relating to Africa

Description from Erikson, Med Res. Counc. Spec. Rept Ser. 203, 1935, 18

Unicellular branching mycelium forming small dense pink colonies with short straight sparse white aerial mycelium.

Gelatin, Irregular pink flakes; no liquefaction.

Agar · A few flat pink discoid colonies Glucose agar: Minute red discrete round colonies and piled up paler pink mass with thin white acrual mycelium.

Giveerel agar: After 2 weeks, small heaped-up colorless masses with pink tinge around the colorless colonies, margin depressed, after 3 weeks, abundant. piled up, pale pink growth

Ca-agar After 1 week, small, round, colorless colonies with red centers, margins aubmerged; after 2 weeks, growth bright cherry-red, confluent, with color-

less margin

Dorset's egg medium · Small colorless blister colonics, partly confluent, becoming wrinkled, depressed into medium; slight liquefaction

Serum agar Trregularly round, raised. wrinkled, colorless colonies, becoming dry, pink and flaky; Liter piled up.

brownish, friable

Inspissated serum. After one week, smooth, round, colorless colonies with submerged margin, in confluent patches pink and pitted into medium; after 2 weeks, medium broken up, slight liquefaction; after 3 weeks, liquid dried up, colonies umbilicated, raised, dry and friable

Broth Small pink colonics embedded In coherent flocculent mass

Synthetic sucrese solution Small pink granules in sediment after I week; colonies of medium size, coherent, after 3 necks. Potato agar: Bright red growth, small round colonies with colorless submerged margins, and piled up patches with stiff sparse white acrial mycelium.

Litmus milk: Bright red surface growth, liquid unchanged after one month; havid opaque reddish-purile after 2 months, hydrolyzed, clear winered after 3 months.

Source: From a case of mycetoma of a foot in South Africa.

63. Streptomyces gallicus (Erikson) comb. nov. (Actinomyces gallicus Erikson, Mcd. Res. Counc. Spec. Rept. Ser. 203, 1935, 36.) Fmm Latin gallicus, of the Gauls (French).

Description from Erikson (loc. cit., p. 24).

Mycclium shows lateral highly refractive bodies which appear almost identical with the singly situated spores found in Micromonospora chulceae.

Gelatin. Scant irregular pink growth: liquefaction very slow, only slight degree in 20 days.

Agar: A few transparent minute pink . colonies; growth becomes partly confluent.

Glucore sgar: No growth. Giverrol agar. No growth.

Cznyck's agar. No growth.

Coon's sgar: Minute colorless to pinkish colonics Ca-agar Glossy pink pinhead colonies.

Potato agar. Pale pink, moist, granular growth.

Serum agar: Pinpoint colonies, pink, shining.

Blood agar: Abundant growth, minute. discrete, round, pink colonies, some aggregated in confluent narrow bands. No hemolysis.

Dorset's egg medium. Minute colonies. becoming confluent, tangerine-colored.

Inspissated scrum. Abundant, pink, membranous growth, becoming reddishbrown; later discrete colonics at margio. clear on reverse side. No liquefaction

Broth: Pinkish flakes. Synthetic sucrose solution: A few fine

white focculi.

Synthetic glycerol solution: A few small round white colonies.

small round white colonies.

Milk Coagulated; peptonized; yellowish-nink surface ring.

Litmus milk: No coagulation or peptonization; no change in color.

Potato plug: Very slow growth, a few minute translucent pink colonies after 16 days; after 21 days, considerable increase in number of colonies, still small and discrete After 2 months, colonies 1 to 2 mm in diameter, bright coral, tending to be umblicated and heaped up. Tyrosine agar: Reaction negative.

Source: From blood culture in a case of Banti's disease

64. Streptomyces pelletlert (Laveran) comb. nov. (Micrococcus pelletiers Laveran, Compt. rend Soe. Biol., Paris, 61, 1906, 340; Oespora pelletiers Thiroux and Pelletier, Bull Soc. path exct., 5, 1912, 585; Nocerdia pelletieri Thiroux, see Pinoy, Bull Inst. Past, 11, 1913, 335; Discompces pelletiers Brumpt, Précis de Parasitol., Pans, 2nd ed., 1913, 970; Actinomyces pelletieri Brumpt, ibid., 4th ed., 1927, 1204.) Named for M. Pelletier who first isolated this species.

Pelletier who first isolated this species. Description from Erikson, Med. Res. Council Spec. Rept. Ser. 203, 1935, 21

Thiroux and Pelletier (Bull Soc. path. exot., 5, 1912, 585) considered that their cultures resembled Nocardia madurae, but they grew the organism only on Sabouraud's gelatin, on which it appeared in a constantly red, easily de-Nocardia indica was tachable form regarded as identical by Pinoy, although in the original description by Laveran the organism was called Micrococcus pelletiers, owing to the fact that no mycelium was seen, merely coccord bodies cardia genesii Froes (Bull Inst. Past., 29, 1931, 1153) is described as closely allied, the distinction being founded upon the fact that the red grains were smaller in size and much more numerous. but no cultural details are given.

Mycclium composed of slender straight and not very long filaments, forming small dense pink colonies with a few short straight isolated aerial branches.

Gelatin: Slight liquefaction; few pink flakes; later almost completely liquefied. Agar: Minute colorless colonies and

piled up pale pink masses.
Glucose agar: Poor growth, a few

minute pink colonies.

Glycerol agar: Poor growth, a few moist pink colonics.

Ca-agar: Colorless small colonies, after 1 week, confluent skin, pink, buckled; medium discolored later.

Coon's sgar: Poor growth, creamcolored with pink center, mostly submerged.

Potato agar: Colorless blister colonies; after 3 weeks, colonies larger, showing concentric zones, submerged margins and occasional zone or tuft of white aerial mycelium, pinkish coloration

Dorset's egg medium: Abundaut, wrinkled, pink skin with small discrete colonies at margin in six days; later surface rough, mealy; considerable liquefaction in 17 days.

Serum agar: Moist cream-colored growth tending to be heaped up, discrete colonies at margin; becoming umbilicated.

Inspissated serum: Round, moist, colorless colonles.

Blood agar: At first a few pinhead, cream-colored colonies, no hemolysis; later colonies dense, button-shaped, with narrow fringed margin.

Broth Small, minute, pink, clustered

Synthetic sucrose solution: Small, pink colonies in sediment; later minute colonies adhering to side of tube.

Milk: Soft curd; half-digested; peptonization complete in 20 days.

Litmus milk: Pink surface growth,

sparse, yellowish-pink, irregularly piled up, portions with scant white aerial mycelsum; after 6 months abundant highly piled up small rounded pink masses, scant white serial mycelium persistent.

Source: From a case of erimson-grained mycetoma in Nigeria (E. C. Sraith, Trans R. Soc. Trop Med Hyg, 22, 1928, 157).

Habitat. Human infections so far as known.

65 Streptomyces listeri (Erikson) comb nov. (Actinomyces tisters Erikson, Mcd Res. Council Spec. Rept. Ser 203, 1935, 36) Named for Dr Joseph Lister, the father of antiseptic surgery

Description from Erikson (loc cit, n. 23).

Long slender filaments, many bosely wavy, forming a dense apreading mycellum which rapidly grows into a membrana on most media. Aerial mycelium very slow and inconstant in appearance, short and atraight, confide avail

Gelatin. Slight liquefaction; round white surface colonics; after 45 days, confluent skin, almost completely liquefied.

Agar. Smooth, round, moist, creamcolored, margin depressed, center elevated, closely adherent; becoming imbilicated, with a myceloid margin

Glucoso agar: Cream-colored, glistening, pinpoint colonies; later aggregated in convoluted skin.

Glycerol agar. Abundant, most, eream-colored growth, colonies elevated, piled up; powdery white aerial mycehum. After 20 days, skin deeply buckled; colorless with exuded drops.

Ca-ager: Poor growth, a slight biscustcolored membrane

Totato agar: After one week, extensive growth, colorless submerged colonies, warted surface; dirty pink coloration after 2 weeks; scant white aerial mycelium after 4 months.

Dorset's egg medium: No growth Blood agar: Small, round, ereamcolored colonies, smooth translucent surface; no lictnolysis.

Serum agar: Small, irregular, moist, erram-colored colonies, tending to be

heaped up; later somewhat transparent. Inspissated scrum. Abundant growth, colorless shiny colonies, centrally ele-

vated, becoming confluent Broth: Small, round, white colonies in sediment.

Glucose broth Small, white, nodular colonies: later abundant flocust.

Synthetic sucrose solution: Delicate white colonies in suspension and in sediment.

Litmus milk: Coagulation. No change in reaction.

Potato plug: Abundant, dull, brownish, wrinkled skin with white acrial myeelium; large, stellate, fluffy, white colonies in liquid at base.

Source: From human material Strain from Lister Collection

Habitat From human infections so far as known.

66. Streptomyres upcottil (Uriken) comb nor. (A new pathogenie form of Streptothriz, Gilvon, Jour Bact and Path, £3, 1920, 337, Actinomyres upcottin Erikson, Med Res Council Spec. Rept. Ser 203, 1935, 36) Named for Dr. Harold Upcott, the surgeon who first secured the culture

Description from Erikson (loc. cit., p 22)

p 22)
Filaments characteristically long, straight, much intervoiven and ramified; typical unreellular mycelium, usually forming medium to large heavy carticlagmous colonies Gilson states that the threads vary in thickness and show septa, but this has not been confirmed A very slight transient near an syclum appeared on one agar slope, but this has not been repeated on any slide microculture on any medium Flightly areafast.

Gelstin Abundant flocculent growth

along streak, round cream-colored colonies on surface l'artly liquefied in 14 days; complete liquefaction in 2 months

Agar: Smooth, shining, round, ercamcolored colonies, margin submerged,

scant white serial mycelium in one week; colonies large (up to 10 mm in diameter). centers elevated, greenish tinge, very sparse aerial mycelium in two weeks; the aerial mycelium disappears and large radial grooves appear in most colonies in 3 weeks.

Glucose agar: Smooth, round, creamcolored colonies, margin depressed, centers elevated, hollow on reverse side: later a coherent membranous growth. .

piled up, vellowish,

Glycerol agar: Small, round, ereamcolored, glistening colonies, heavy texture, margins submerged; later, colonies umbilicated, tending to be piled up; after 6 weeks, growth very much convoluted and raised, broad submerged margin, alightly reddish medium.

Coon's agur: Small, radiating, white colonics, growth mostly submerged.

Ca-agar: Email, colorless membranous growth with undulating margin; later, centrally depressed into medium.

Potato agar : Poor growth, small, colorless blister colonics, medium slightly

discolored.

Dorset's egg medium: Round, flat, colorless, scale-like colonies, some marked by concentric rings and slightly hollowed in center; growth becomes yellow brown.

Serum agar: Large colonics (3 to 4 mm in diameter), colorless, granular, centrally elevated, depressed at margin, re-

sembling limpets.

Blood agar. Large drab heavily textured colonies; no aerial mycelium; no hemolysis.

Broth: Large coherent mass composed

of fluffy colonies.

solution: sucrose Synthetic growth, minute white colonies.

Carrot plug: Colorless, spreading, moist, wrinkled growth in six weeks; later a dull greenish-brown, moist, very much wrinkled and depressed skin.

Source - From the spicen in a case of

acholuric jaundice.

Habitat: From human infections so far as known.

67. Streptomyces hortonensis (Erikson) comh. nov. (Actinomyces horton Erikson, Med. Res. Council Spec. Rept. Ser. 203, 1935, 36.) Named for the Horton War Hospital at Epsom, England from which the culture was obtained.

Description from Erikson (loc. cit., p. 22).

Typical germination into very slow growing unicellular mycelium composed of long slender straight branching filaments. Very sparse straight aerial mycelium produced only once on potato. Non-acid-fast.

Gelatin: Round cream-colored colonies on surface and a few mm below. No

liquefaction.

Agar: Very slow growth, a few smooth cream-colored coiled colonies in 19 days: after 2 months, liberal, irregular, convoluted growth.

Glucose agar: Coiled and heaped up cream-colored translurent masses; after 2 months, growth rounded, elevated, ridged outwards from hollow center.

Glycerol agar: Coiled, colorless, lustrous patches, isolated colony with cen-

tral depression.

Serum agar: Poor growth, small smor-

phous cream colored mass. Inspissated serum: Intricately coiled

cream-colored growth. No liquefaction. Broth: Flakes. Synthetic sucrose solution:

growth, a few flakes.

Synthetic glycerol solution: Delicate white flocculi at base.

Litmus milk: Green surface growth, liquid hydrolyzed, partly clear purple; later decolorized, brown.

Potato agar: Colorless blister colonies in one week; dull green heaped and coiled mass after 3 weeks; medium becomes

slightly discolored.

Potato plug: After 3 weeks, abundant, coloriess, umbilicated, round colonies, some coiled in raised masses; later, liberal olive-green growth, piled up, dense, velvety gray-green aerial mycelium at top of slant, small round fluffy white colonies in liquid at base.

Source: From pus-containing typical actinomycotic granules from parotid abacess.

Habitat: From human infections so far as known.

68. Streptomyces gibsonil (Erikson) comb nov. (Actinomyces gibsonie Erikson, Med. Res. Council Spec. Rept Ser. 203, 1935, 36 ) Named for Prof, Gibson of Oxford

Description from Erikson (loc. cit., p 15).

Young growing myeclium branches profusely at short intervals; later grows out into long frequently wavy filaments; twisted hyphae also seen on water sgar. Power of producing acrist myceliura apparently lost.

Gelatin: Dull white flakes sinking as medium liquefies: liquefaction complete in 12 days.

Agar Small, cream-colored, depressed, nartly confluent colonies, becoming an extensive wrinkled cream-colored akin.

Glucose agar: Cream-colored wrinkled membranous growth.

Potato agar Wrinkled glistening membranous growill.

Serum agar · Small moist cream-colored colonies growing Into medium.

Dorset's egg medium · Small, round, smooth, colorless colonies with conscally elevated centers.

Inspissated serum : Innumerable colorless pinpoint colonies with scant white acrial mycelium at top; after 8 days, a coherent wripkled skin with brownishred discoloration at reverse, medium becoming transparent; completely liquefied, pigmented brown in 15 days

Blood agar Yellowish confluent bands, arregularly wrinkled, with small discrete colonies, clear hemolytic gone.

Broth Sediment of floceuli, some round and fan shaped colonics.

Synthetic auerose solution: Very delicate a hite flocculi.

Potato plug: No growth.

Starch not hydrolyzed. Milk · Congulated; pertly peptonized. Tyrosine agar: Negative reaction.

Source: From the splcen in a case of scholuric inundice. Injected into a monkey, and reisolated.

Habitat: From human infections so far as known.

69. Streptomyces beddardli (Enkson) comb nov. (Actinomyces beddardni Erikson, Med. Res. Council Spec. Rept Ser. 203, 1935, 36.) Presumably named for the surgeon who first secured the culture.

Description from Erikson (loc. cit.

p. 13).

Rapidly growing, dense, spreading mycelium composed of very long slender filaments, many wavy or closely coiled, particularly on glucose agar, spimls less marked or lacking on poorer nutritive media like synthetic glycerol agar or water agar Acrial mycelium sparse. short, straight on synthetic glycerol agar, much slower and more plentiful on glucose agar; later shows long, very fine spirals breaking up into small oval conidua; acrial hyphae straighter and more branched with shorter conidionhores on starch agar Non seid-fast.

Gelatin: Dull white flakes sinking to bottom as medium liquefies; liquefaction complete in 8 days

Agar: Coloricas, coherent, arinkled, membranous growth with aubmerzed margin; after 3 months, medium discolored, scant white aerial mycelium at top

Glucose agar: Wrinkled membranous growth: after 2 months, scant white aerial mycelium.

Glycerol agar: Small, eream-colored. discrete colonies becoming confluent. under surface much burkled.

Potato agar. Moist, cream-colored skin. convoluted, closely adherent.

Ca-agar: Extensive, moist, creamcolored, wrinkled, membranous growth,

Coon's agar: Frant, eream-colored. membranous growth.

Starch agar: Spreading, colorless growth, considerable white serial my. celman.

Blood agar: Hemolysis. Growth in uniformly striated colorless bands, occasional round colonies at margin. Dorset's egg medium: Extensive, very wrinkled, membranous growth, surface

bright yellow. After 2 months, considerable liquefaction. Serum agar: Wrinkled, glistening, eream-colored, membranous growth.

Inspissated serum. Colorless smeary

growth, reverse becoming transparent. starting to liquely at base; completely liquefied and brown in 12 days.

Suspended and sedimented coloriess flocculi, some small round colonies.

Synthetic sucrose solution: Abundant white colonies in coherent mass near bottom of tube; large shell-shaped masses Synthetic glycerol solution: At first, a

few round white colonies in suspension: later, large branched feathery mass at bottom

Milk: Coagulated, later peptonized. Litmus milk. Medium deep blue, be-

coming hydrolyzed to clear purple, Potato plug. Colorless moist membranous growth with scant white aerial my-

celium at top of plug Starch is hydrolyzed.

Tyrosine agar Reaction negative

Source. Human spleen in a case of spleenic anemia

Habitat From human infections so far as known

70. Streptomyces kimberi (Erikson) comb. nor. (Actinomyces kimbert Erikson, Med Res Council Spee Rept. Ser. 203, 1935, 36 ) Presumably named for the surgeon who first secured the culture. Description from Erikson (loc. cit.

p 14). Mycelium of long straight profusely

branching filaments forming circumscribed colonies on all media with abundant production of short straight and branched aerial mycelium, small round conidis Non-acul-fast

Gelatin Liquefidd Smooth shining

colonies becoming powdery white with aerial mycelium, floating on liquefied medium. No pigmentation.

Agar: Smooth round moist creamcolored colonies, 1 mm in diameter; after 17 days, white powdery acrial mycelium. Glucose agar: Discrete cream-colored colonies becoming confluent, white aerial myeelium.

Glycerol agar: Moist cream-colored colonies becoming confluent, white aerial mycelium.

Potato agar: Extensive growth covered by white powdery aerial mycelium; large colorless exuded droplets.

Wort agar: Heavy brownish lichenoid colony; after 30 days, a white serial mycelium.

Ca-agar: Dull cream-colored scaly growth, covered by chalky white serisl mycelium.

Coon's agar: Extensive growth, white acrial mycelium in annular arrangement

Czapek's agar : Small colonies covered with white aerial mycelium.

Blood agar . Many large colonies, cream. colored, tough, smooth, glistening, with margin depressed; no hemolysis.

Serum agar: Moist, cream-colored honeycombed akin, seant white serial mycelium.

Dorset's egg medium : Closely adherent scale-like colonies, centrally elevated, with white agrial mycelium.

Inspissated serum: Rapid spreading growth, discrete round colonies at margin, completely covered with white aerus! mycelium, colorless transpired drops; slight softening at base.

Broth: Small round colonies in sediment in 2 days; supernatant colonies with white aerial mycelium and large hollow flakes in sediment in 15 days; occasional reddish-brown coloration.

Synthetic sucrose solution: Round white colonies at bottom; later small stellate colonics in suspension and a few supernatant with white aerial mycelium.

Synthetic glyceral solution: Round white colonies at bottom; later coherent mulberry like mass composed of fluffy

round portions; after 15 days, irregular wispy flocculi and large coherent mass.

Milk: Coagulation; no peptonization; initial pinkish-brown ring descends until medium is dark brown throughout (2 months).

latmus milk: Blue coloration, hydrolyzed to clear purple in 2 months.

Starch not hydrolyzed.

Tyrosine agar. Reaction negative. Source Blood culture of a woman with acholuric jaundice.

Ilabitat, From human infections so far as known.

71 Streptomyces somallensis (Brumpt) comb mov (Indicila somalensis Brumpt, Arch Parsait, Paris, 10, 1906, 489, Discomyces somaliensis Brumpt, Précis de Parusatologie, Paris, 2nd ed., 1913, 907, Indicilopsis somaliensis Brumpt, bid , Nocardia somaliensis Brumpt, bid , Nocardia somaliensis Chalmers and Christopherson, inn Trop Med and Parautt, 10, 1916, 239; Siterptothriz somaliensis Muescher, Arch Derm Syphulis, 184, 1917, 297; Actinomyces somaliensis sit John-Brooks, Med Ries Council Syst of Bact, London, 8, 1931, 75) Named for the country of origin, French Somaliana.

Description from Erikson (Med Res. Council Spec. Rept. Ser. 203, 1935, 17).

Simple branching unicellular myochum with long straight filaments, forming cirenmscribed colony crowned with short atraight aerial myoclium

Gelatin Cream-colored colonies, meilium pitted; complete liquefaction in 10 days, hard black mass at bottom

Agar. Abundant yellowish granular growth with small discrete colonies at margin, later growth colorless, colonies imbulicated

Glucose agar: Poor growth, moist cream-colored elevated patch

Glycerol ager: Abundant growth, minute round to large convoluted and piled up masses, colorless to dark gray and black

Ca-agar: Round cream-colored colonies, depressed, umbilicated, piled up, thin white aerial mycelium; colonies become pale brown

Potato agar: Small round colorless colonies, zonate margin depressed, confluent portion dark greenish-black.

Blood agar: Small dark brown colonies, round and umbilicated, piled up confluent bands, reverse red-black; hemolysis.

Dorset's egg medium: Extensive colorless growth, partly discrete; becoming opaque, cream-colored, very wrinkled; later rough, yellow, mealy, portion liquid. Serum agar: Spreading yellow-brown

akin, intricately convoluted
Inspissated serum. Cream-colored

coiled colomes, medium pitted, transparent and slightly liquid

Broth: A few round white colonies at

surface, numerous fluffy masses in sediment, later large irregular mass breaking into wasps.

Synthetic sucrose solution: Minute round white fluffy colonies in sediment; after 17 days, scant wispy growth

Milk: Soft semi-liquid congulum which undergoes digestion; heavy wrinkled surface pellicle, completely liquefied in 12 days

Litmus milk Soft ecagulum, partly digested, blue surface ring; clear liquid in 12 days

Potato plig Abundant growth, colonies round and oval, partly piled up in meettes, frosted with whitish gray aerial mycehum, plug discolored, after 16 days, aerial mycehum transient, growth nearly black.

Although Streptomyces annoticents has been known for a long time, there has been until recently no idealed descriptions of the organism beyond the fact that it proseaves a distinctly hard sheath around the grain which is insoluble in potash and cau ile javelle. The rare occurrence of repta and occasional intercalary chlamydospints is reported by Brutagit (Arch. Parasit, 19, 1935, 562), but has not fisen confirmed by Erikson (Gec. ett.). Chalmers and Christople room (Am. Trop Med. Parasit., 10, 1916, 523).

merely mentioned the growth on potato as yellowish-white and lichenoid without describing any aerial mycelium. Balfour in 1911 reported a case but gave no data, and Fülleborn limited his description to the grain (Arch. Schiffs. Trop. Hys., 15, 1911, 131). This species was first placed in Indiella, a genus of fungi, by Brumpt (1905, loc. cit.). Later Brumpt (1913, loc. cit.) proposed a new genus or subgenus, Indiellopsis, containing the single species Indiellopsis

Source: Yellow-grained mycetoma, Khartoum (Balfour, 4th Rept. Wellcome Trop. Res. Lab., A. Med., London, 1911, 365).

Habitat: This candition has been observed by Baufford in French Somaliland, by Balfour (loc. cit.) in the Anglo-Egyptian Sudan, by Fulleborn (loc. cit.) in German So. West Africa and by Chalmers and Christopherson (loc. cit.) in the Sudan.

72. Streptomyces panjae (Erikson) comb. nos. (Actinomyces panja Erikson, Med. Res. Council Spec. Rept. Ser. 203, 1935, 38.) Named for Dr. Panja who first secured the culture.

Description from Erikson (loc. cit., p. 16).

Unicellular mycelium with slender branching filaments; very small round colonies; no actial mycelium visible on any medium, but occasional isolated aerial branches Non-acid-fast.

Gelatin: Complete liquefaction in 4 days.

Agar: Colorless irregularly piled up convoluted growth; after 1 month, easily detachable, brownish.

Glucose agar: Small colorless coiled mass in 1 week, heaped up green growth

in 2 weeks.
Glyrerol agar: Poor growth, scant

colorless patch.

Ca agar: Colorless to pink apreading growth with minute discrete colonies at margin; after 2 weeks, bright red mass,

buckled and shining, colorless submerged margin.

Coon's agar: Small submerged colorless growth.

Potato agar: Small elevated convoluted colorless masses with purple tinge in center.

Dorset's egg medium: Small round tough colorless colonies, margin well embedded, after 3 weeks, colonies elevated, warted, darkened, medium discolored and broken; slight degree of liquefaction, medium dark brown.

Serum agar: Colorless, glistening, piled up, convoluted mass.

Inspissated scrum; Small round blister colonies and irregularly convoluted patches deeply sunk in pitted medium; after 2 weeks, medium transparent, slight degree of liquefaction.

Broth: Flakes and minute colorless colonies.

Glucose broth: Poor growth, scant flakes, pinkish.

Synthetic sucrose solution: Pinkish flocculi; after 3 weeks, moderate growth, minute colorless colonies.

Milk: Congulation; pale green surface growth; mostly digested in 2 weeks.

Litmus milk: Soft cogulum, color unchanged; after 2 months, mostly digested, residue cogulum light purple.

Source: From an ulcer of the abdominal wall, Calcutta.

73. Streptomyces willmore! (Erikson)
comb. nov. (Actinomyces willmorei Eriknon, Med. Res. Council Spec. Rept. Ser.
203, 1935, 36.) Named for Dr. Willmore
who isolated the culture.

Description from Erikson (loc. cit.,

p. 19).
Germination usual, but growing unicellular mycelium frequently branches
at very short intervals, presenting peculiar clubbed and budding forms with
occasional separate round swollen cells
which may represent the cystics of other
writers. The filements are characteristically long, homogeneous, and much
interwoven. Aerial mycelium is profuse

in most media, with a marked tendency to produce loose spirals (water and synthetic glycerol agar) with chains of ellipsoidal conidia. Thick aerial clusters may also be formed.

Gelatin: Minute colorless - colonies; haucfaction.

Agar, Heavy folded colorless lichennid growth, rounded elevations covered with white aerial myeelium; later, submerged margin, round confluent growth, serial mycelium marked in concentric zones

Glucose agar: Coloricas wrinkled confluent growth with smooth entire margin. large discrete colonica like flat resettes: after 4 months, scant white aerial mycelium.

Glycerol sgar: Round smooth ereamcolored colonies, heavy texture, margin submerged, stiff sparse aerial spikes; after 3 weeks, colonics large (up to 10 mm in diamoter).

Ca-agar. Spreading colorless growth. pitting medium, submerged undulating margin: very scant white serial mycelium.

Coon's sgar · Opaque white growth extending irregularly (up to 3 mm) into medium, margin smooth and submerged. center raised, greenish tinge covered with white aerial mycelium; after 3 weeks, markin green, central mass covered by gray acrial mycelium.

Potato agar . Fair growth, partly submerged, covered with grayish-white aerial mycelium, medium becomes discolored.

Blood agar Heavily textured small deab colonies, acrial mycelium microscopleal: no hemolysis.

Dorset's eeg medium, Large, round, colorless, scale-like colonies, radislly wrinkled; growth brownish, medium discolored in 2 weeks.

Serum agar: Smooth colorless discoid colonies; marked umbilication after 2 weeks.

Broth: Large fluffy white hemispherical colonies, loosely coherent.

Synthetic sucrose solution: A few large round white colonies with smooth partly zonate margins, lightly coherent in sediment: later amaller colonies in suspension nttached to side of tube.

Milk: Congulation; one-third peptonized.

Carrot plug: Colorless raised colonies with powdery white serial mycelium: after 1 month, very much piled up, aerial mycelium gray; after 2 months, superabundant growth around back of plug. confluent, greatly buckled, all-over gray aerial mycelium.

Source: Streptothricosis of liver (Willmore, Trans. Roy Soc. Trop. Med. Hyg., 17, 1924, 344),

Habitat: From human infections so far as known.

\*Appendix; The following names have been used for species of Streptomuces. Many of them are regarded as new by their authors merely because they were isolated from a new type of lesion, or from some animal other than man. Others are inadequately described species from air, soil or water. Relationships to other better described species are usually very obscure. Some of the species listed here may belong in the appendix to the genus Nocardia.

Actinomyces aerugineus Wollenweber. (Arb d. Forschungsinst. f. Kartoffelleu. 1920, 16 ) From deep scale on potato. Actinomyces albidofuscus Neukirch.

(Actinomyces albido fuscus Berestnew. Inaug. Diss., Moskow, 1897; see Cent. f. Rakt., I Abt., 24, 1899, 707; Neukirch. Inaug. Diss , Strassburg, 1902, 3.) From grain.

Actinomyces albidus Duché. (Ency. clopédie Mycologique, Paris, 6, 1931,

Actinomyces alboatrus Waksman and

This appendix was originally prepared by Prof. S. A. Waksman and Prof. A. T. Henrici, May, 1913; it has been developed further by Mrs Eleanore Heist Clise, Geneva, New York, August, 1915.

Curtis. (Soil Science, 1, 1916, 117.) From adche soil.

Actinomyces alboviridis Duché. (Encyclopédie Mycologique, Paris, 6, 1934, 317.)

Actinomyces albus (Rossi Doria) Casperini. (Streptotrus (sie) alba Rossi Doria, Ann. d. 1st. d'Ig. sper. d. Univ. di Roma, I, 1801, 421; Streptothris Nos. 2 and 3, Almquist, Ztschr. I. Hyg., 8, 1890, 189, Oospora doriae Sauvageau and Radais, Ann Inst. Past., 6, 1892, 251; Actinomyces boois albus Gasperini, 1892, 1893; Casperini, Cent. 1 Bakt., 15, 1894, 1893; Ageneral name applied to the most common streptomyces in air and water.

Actinomyces albus asporagenes Berestnew. (Inaug. Diss., Moskow, 1897; see Cent. f. Bakt., I Abt., 24, 1898, 708)

Actinomyces albus var. ochraleucus Wollenweber (Arb. d. Forschungsinst. fur Kartoffelbau, 1920, 16.)

Actinomyces albus - vulgaris Ciani (Quoted from Baldacci, Boll. Sez Ital. Soc. Internaz. di Microbiol, 9, 1937, 140.)

Actinomyces almquiati Duché (Duché, Encyclopédie Mycologique, Paris, 6, 1934, 778.) From culture laheled Actinomyces albus (Kransky) Waksman and Curtis (Soil Set, 1, 1916, 117; said to resemble Streptothrix No. 1, Almquist, Zischr. f. Hyg., 8, 1890, 189).

Almquist, Zischr. f. Hyg., 8, 1800, 189). Actinomyces alm. Pekko (Cent. f. Bakt., II Abt., 27, 1910, 451) From swelllings of the roots of Almus glutinosa

Actinomyces annulatus Wollenweber. (Arb Forschungsinst, für Kartoffelbau, 1920, 16) From dark-colored potato stem.

Actinomyces (Streptothrix) annulatus Beigerinek (Folia Mierobiologica, 1, 1912, 4.)

Actinomyces aurea (du Bois Saint Sévérn) Ford (Streptokriz aurea du Bois Saint Sévérin, Arch de méd. nav , 1895, 252; Nocardia aurea Castellani and Chalmers, Man Trop. Med., 2nd ed., 1913, 818, Oospora aurea Sartory, Clasmp. Paras, Homme et Anim , 1923, 818; Ford, Texth of Bact., 1927, 220; not Actinomyces aureus Waksman and Curits, Soil Science, 1, 1916, 124 ) Possibly synonymous with Actinomyces aureus Lachner-Sandoval, Die Strahlenpilze, 1893, according to Lieske, Morphol. u. Biol. d. Strahlenpilze, Leipzig, 1921, 26. Found in conjunctivitis.

Actinomyces bellisari Dodge. (Streptolhrz alba Bellisari, Ann. Ig. Sperim. 14, 1904, 467; Oospora alba Sartory, Champ. Paras. Homme et Anim, 1923, 819; Dodge, Medical Mycology, St. Louis, 1935, 744.) Isolated in a warchouse in Naples from the dust of cereal coming trom California.

Actinomyces boris var. nigerianus Erikson. (Med. Res. Council Spec. Rept. Ser. 203, 1935. 20 and 36.) From streptothricosis of the skin of cattle in Nigeria.

Actinomyces candidus (Petruschky)
Bergey et al. (Streptohriz candidus
(Gedanensis II) Petruschky, Verhandl.
d. Kongr. f. innere Med., 1895; see
Petruschky, in Kolle and Wassermann,
Handb d. path Mikroorg, 2 Auf. f.
1913, 285 and 294; Nocardia candidu
Castellani and Chalmers, Man. Trop.
Med., 2nd ed., 1913, 818; Discomyers
candidus Brumpt, Précis de Parisitol,
Paris, 3rd ed., 1922, 980; Bergey et al.,
Manusl, 1st ed., 1923, 347.) From human lune.

Actinomyces carneus (Rossi Doria)
Gasperine. (Sireptolriz carnea Rossi
Doria, Ann. Ist. d'Ig. sper. Univ. Roma,
1, 1891. 415; Gasperini, ibid., 2, 1892,
222; Gospora carnea Leimann and Neumann, Bakt. Diag., 1 Aufl., 2, 1893,
388; Cladothrix carnea Mack, Traité
Pratique de Bact., 4th. ed., 1991, 1990;
Discomspees carneus Brumpt, Précis de
Parasitol., 2nd ed., 1913, 976; Nocardia
carnea Castellani and Chalmers, Man.
Trop Med., 2nd ed., 1913, SIS.) From

Actinomyces carnosus Millard and Burr (Ann. Appl. Biol., 15, 1926, 601.)

From scab on potato.

Actinomytes casei Bernstein and Morton (Jour. Bact., 27, 1931, 625.) Thermophilic. From pasteurized cheese. Actinomyces cot: (Rivolta) Gasperini. (Discomyces cati Rivolta, 1878; Gasperini, Cent. f. Bakt., 15, 1894, 684) Cause of a disease in a cat.

Actinomyces cerebriformis Namyslowski. (Namyslowsk), Cent. f. Bakt., I Abt., Orig., 62, 1912, 564; Streptothriz cerebriformis Chalmers and Christopherson, Ann. Trop. Med. and Parast. 19, 1916, 273, Nocardia cerebriformis Yuillemin, Encyclopédic Mycologique, Paras, 2, 1931, 126) From an infection of the cornea of the human eye.

Actinomyces cereus, (Quoted from Lieske, Morphol. u. Biol d Strahlen-

pilze, Leipzig, 1921, 33) Actinomyces chromogenus (Gasperini) (Streptotriz nigra Gasperini Doria, Ann d. Ist d'Ig sper. d Univ di Roma, 1, 1891, 419; Streptotriz cromooena (sie) Gasperini, according to Rossi Doria, idem, Gasperini, ibid , 2, 1892. 222, Oospora chromogenes Lehmann and Neumann, Bakt Diag , 1 Aufl , 2, 1896, 389, Cladothriz chromogenes Mace, Traité Pratique de Bact , 4th ed , 1901, 1075, Actinomuces niger Brumpt, Précis de Parasitol , Paris, 4th ed , 1927, 1206 ) A general name for streptomyces from air producing a dark chromogenesis on protein nicdia

cinereonigeraromaticus Actinomyces Neukirch (Actinomyces einereus niger aromaticus Berestnew, Inaug. Diss., Moskon, 1897; see Cent f. Bakt, I Abt, 24. 1898, 707; Neukirch, Inaug. Diss , Strassburg, 1902, 3, Nocardio cinerconigra Chalmers and Christopherson, Ann Trop Med and Parasit , 10, 1916, 271, Streptothrix einereonigra aromatica, attributed to Berestney by Chalmers and Christopherson, iden; Actinomyces cinereo-niger, quoted from Lieske, Morphol n Biol d Strahlenpilze, Leipzig, 1921, 33 ) From grain.

Actinomyces citreus Gasperini (Gasperini, Cent. f. Bakt, 15, 1891, 684, Streptolibris citrea Kruse, in Plügge, Die Mikroorganismen, 2 Auff. 2, 1896, 63, unt Actinomyces citreus Krainsky, Cent f. Bakt., 11 Abr., 41, 1914, 662) Actinomyces clavifer Millard and Burr. (Ann. Appl. Biol., 13, 1926, 601.) From seab on potato and from soil.

Actinomyces coroniformis Millard and Burr. (Ann Appl Biol, 13, 1926, 601.) From peat soil.

Actnomyces croterifer Millard and Burr. (Ann. Appl Biol., 15, 1926, 601.) From seab on notato

Actinomyces cloncae Brussoff. (Cent. f., Bakt., 11 Abt. 49, 1019, 97) From mud. Actinomyces cretoceus (Kruger) Wollenweber. (Osspora cretacea Krüger, Berichte der Versuchsstat. f. Zueker rohrs, Kergok-Logal, 1800; Wollenweber, Arbeiten d'Forschungsmittiut für Kar-

toffelbau, 1920, 16) From potato scab. Actinomyces dicksom: Erikson. (Med Ret Council Spec. Rept Ser. 203, 1935, 17.)

Actinomyces elostica Söhngen and Fol. (Cent. f. Bakt., II Abt., 40, 1914, 92.) From garden carth

Actinomyces ferrugineus Naumann. (Kungl Svenska Vetenskapsakad. Handi, I, 62, Part 4, 1921, 45) From Aneboda region of Sweden. Deposits ferric hydroude about the mycelial threads

Actinomyces filiforms (Boss) Nannazi. (Bocullus filiforms Boss, 1807, not Bocullus filiforms Tils, Zischr f Hyg. 9, 1890, 291; not Bacullus filiforms Migula, Syst. d Bakt, 2, 1900, 387, Nocardus filiforms Vullemin, Encyclopedie Mycologique, Paris, 2, 1931, 132; Nannizzi, in Pollacei, Tratt Micopat. Umana, 4, 1931, 29) From the human stomach.

Actinomyces fimbriotus Millard and Burr. (Ann Appl Biol , 15, 1926, 601.) From scale on potato

Actnomyces florgriseus Duché. (Uncyclopédie Mycologique, Paris, 6, 1934, 341.) From volcame soils (Martinique). Actnomyces flarus Sanfelice. (Sanfelice, Cent. f. Bakt., Aht., Orig., 50,

felice, Cent. f. Bakt., I Abt., Orig., 39, 1901, 329, Streplothriz flara Sanfelice, ibid; not Streptethriz flara Chester, Manual Determ. Bact., 1901, 362; not Actinomyces flarus Krsinsky, Cent. f.

Bakt., II Abt , 41, 1914, 662.) From

Actinomyces flavus Millard and Burr. (Millard and Burr, Ann. Appl. Biol., 18, 1926, 601; not Actinomyces flavus Sanfelice, Cent f. Bakt., I Abt., Orig., 36, 1904, 359; not Actinomyces flavus Krainsky, Cent. f. Bakt., II Abt., 41, 1914, 662; not Actinomyces flavus Dodge. Medical Mycology, St. Louis, 1935, 752.)

From scab on potato. Actinomyces foersteri (Cohn) Gasperini. (Streptothrix foersteri Cohn, Beitr. z. Biol. d. Pflanz., 1, Heft 3, 1875, 186; Cladothriz foersteri Winter, Die Pilze, in Rabenhorst's Kryptogamen-Flora, I Abt., 1, 1884, 60; Nocardia foersteri Trevisan, I generi e le specie delle Batteriacee, 1889, 9; Oospora foersteri Sauvageau and Radais, Ann. Inst. Past , 6, 1892, 252; Gasperini, Cent. f. Bakt., 15, 1894, 684; Discomuces forrsteri Gedoelst, Les champignons parasites de l'homme et des animaux domestiques. Brussels, 1902, 176; Cohnistreptothriz foersteri Pinoy, Bull. Inst. Pasteur, Paris, 11, 1913, 937 ) The first streptomyces to be described. Probably not identifiable. From an inflamed tear duct. Chalmers and Christopherson (Ann Trap. Med. and Parasit., 10, 1916, 273) include Leptothrix oculorum Sorokin, 1881 as a synonym of this species. Actinomyces fusca Schngen and Fol. (Cent. f. Bakt, II Abt., 40, 1914, 87.) From garden earth.

Actinomyces gabritschewskii Neukirch. (Actinomyces of Gabritschewsky, Berestnew, Inaug. Diss , Moskow, 1897; see Cent. f Bakt, I Abt., 24, 1898, 703; Neukirch, Inaug. Diss., Strassburg, 1902,

3.) From water. Actinomyces gedanensis (Löblein) Bergey et al. (Streptothrix gedanensis I, Schoele and Petruschky, Verhandl. d. Kongr f. innere Med., 1897, 550; Streptothrix gedanensis Löhlein, Ztschr f. Hyg. 63, 1909, 11; Nocardia gedanensis Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 255; Discomyces gedanensis Brumpt, Précis de

Parasitol., Paris, 3rd ed., 1922, 984; Bergey et al., Manual, 1st ed., 1923, 347.) From sputum of patient with chronic lung disease.

Actinomyces gibsoni Dodge. (Streptothrix sp. Gibson, Jour. Path. Bact, 23, 1920, 357; Ocspora sp. Sartory, Champ. Paras. Hamme et Anim., 1923, 776; Dodge, Medical Mycology, St. Louis, 1935, 722.) See page 961.

Actinomyces gracilis Millard and Burr. (Ann. Appl. Biol., 18, 1926, 601.) From

scab on potato.

Actinomyces graminearum Berestnew. (Berestnew, Inaug. Diss., Moskow, 1897; see Cent. f. Bakt., I Abt., 24, 1898, 707; Nocardia graminarium (sic) Chalmers and Christopherson, Ann, Trop. Med. and Parasit., 10, 1016, 265; Streptothrix graminarium Chalmers and Christopher-

aon, idem.) From grain. Actinomyces graminis Topley and Wilson, (Aktinomyces, Bostroem, Beitr. path. Anat u. Path , 9, 1891, 1; Topley and Wilson, Princip, Bact. and Immun., 1st ed., 1, 1931, 250; Actinomuces bostroemi Baldacci, Boll. Sez. Ital Soc. Internat. Microbiol., 8, 1937,

141.) From bovine actinomycosis. Actinomyces gruberi Terni. (Terni, Cent. f. Bakt., 16, 1894, 362; Nocardia oruberi Blanchard, in Bouchard, Traite Path. Gen., 2, 1896, 855; Streptothrix grueberi (sic) Sanfelice, Cent. f. Balt., I Abt .. Orig., 56, 1901, 356; Ocspora gruberi, quoted from Nannizzi, Tratt. Micopat. Umana, 4, 1934, 51.) From soil. Produces several pigments on culture media.

Actinemyres guignardi (Sauvageau and Radais) Ford. (Oospora guignardi Sauvageau and Radais, Ann. Inst. Past., 6, 1892, 255; Ford, Textb. of Bart., 1927, 220 ) From dust. Gasperini (loc. cit.) regards this as a possible synonym of Actinomyces chromogenus.

Actinomyces halotrichis ZoBell and Upham. (Bull. Scripps Inst. Oceanography Univ. California, 5, 1914, 273)

From marine mud and kelp. Actinomyces heimi Duché. (Encyclopédie Mycologique, Paris, 6, 1934, 359.)
Actinomyces hoffmanni (Gruber) Gas-

Actinomyces hoffmann (Gruber) Gasperini. (Micromyces hofmann (sie) Gruber, Münch. med. Wochnschr., 1891; also Arch. f. 1892, 262, Gasperim, Cent. f. Bakt., 15, 1894, 631; Arrytolaris, hoffmanni Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 62; Cladothriz hoffmanni Macé, Traité Pratique de Bact, 4th ed., 1901, 1931.) Pathogenic. See pase 976

Actinomyces holmesi (Gedoelst) Nannizzi, (Discomyces holmesi Gedoelst, Champ. Paras. Homme et Anim, 1902, Nannizzi, Tratt. Micopat. Umana, 4, 1934, 49)

Actinomyces hominis Waksman. (Soil Scionce, 8, 1919, 122) Culture received from K. Meyer from Foulerton who ivolated it in 1911 from an abscess of the palm. Waksman (loc. cit.) and Baldacei (Alycopathologis, 2, 1919, 160) regard this as identical with Bostroem's organism (see Actinomyces grammus above) and Baldacel has renamed it Actinomyces innominatus.

Actinomyces incanescens Wollenweber. (Arb. Porsehungsinst. für Kartoffelbau, 1920, 16.) From the soil of potato fields near Berlin

Actinomyces intermedius (Krūger) Wollenweber. (Oospora intermedia Krūger, Berichte der Versuchsstat. f. Zuckerrohrs, Kergok-Legal, 1890, Wollenweber, Arh. d Forschungsinst. für Kartoffelbau, 1920, 16.) From the soil ol potato fields near Berlin.

Actinomyces interproximalis (Fennel) Ford. (Streptothrix interproximalis Fennel, Jour. Inf Dis., 22, 1918, 567; Ford, Textb of Bact, 1927, 195) From the mouth.

Actinomyces invulerabilis (Acosta and Grande Rossi) Lachner-Sandoval (Cladothriz invulnerabilis Acosta and Grande Rossi, Cronica medicoquirungica de la Ilabana, No. 3, 1893; sec Cent. I Bakt., 14, 1893, 14; Streptotriz invulnerabilis Kruse, in Flügge, Die Mikroorganismen, 3 Aufl, 2, 1905, 64; Lachner-Sandoval, Ueber Strahlenpilze, Strasshurg, 1893; Nocardia insulnerabilis Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 271.) From river water.

Actinomyces krausei (Chester) Ford. (Streptofikie aus Eiter, Kruuse, Münch. med. Wehnselir., 42, 1899, 749 and Cent. f. Bakt., I Aht., 25, 1899, 209, also see Petruschky, in Kolle and Wassermann, 2 Aufl., 6, 1913, 267; Streptohriz krausei Chester, Manual Deterna. Bact., 1901, 361; Nocordia krausei Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 263; Discomyces krauses Brumpt, Précis de Parasitol., Paria, 3rd ed., 1922, 993; Ford, Textb. of Bact., 1927, 203.) From actinomycotic pus.

Actinomyces lacertae Terni. (Terni. L'Officiale Sanitario, 1806, 100; Strepta-thris facertae Foulerton, in Allbutt and Rolleston, Syst. of Med., 2, 1912, 200; Ocspora lacertae Sartory, Champ. Paras. Homme et Anim., 1923, quoted from Nannizzi, Tratt. Micopat. Umana, 4, 1934, 51.) From grayish nodules in the liver of Italian hzards (Lacerta viridis and L. agilis).

Actinomyces lathridii (Petruschky) Ford. (Streptuhriz lathridii Petruschky, Verhandl, d. Kong, f inner Med., 1898, Ford, loc cil., 203.) From the beetle, Lathridius rugicollis.

Actinomyces lordensis Millard and Burr. (Ann. Appl. Biol., 15, 1926, 601.) From scale on potato

Actinomyces luteo-roseus Sanfelice, (Actinomyces borns luteoroseus Gasperini, (Cent. f Bakt., 15, 1891, 681; Sanfelice, Cent. f. Bakt., I Abt., Orig., 56, 1901, 335.) Isolated from actinomycotic lesion in extile

Actinomyces marginatus Millard and Burr. (Ann Appl. Biol., 15, 1926, 601.) From ecab on potato.

Actinomyces marinolimosus ZoBell and

Upham. (Bull. Scripps Inst. Oceanng-raphy Univ. California, 5, 1911, 236.) From marine mud.

Actinomyces melanoroscus Roisia. (Wisti Nauk Doslid, Kat. hiaf, Odessa, 1, 1929, 60.)

Actinomyces metchnikori (Sauvageau and Radas) Pard. (Oospora metchnikoni Sauvageau and Radais, Ann. Inst. Past., 6, 1892, 242; Ford, Inc. cit., 220.) From water. Gasperini (Inc. cit.) regyrds this organism as a possible synonym of Actinomyces chromogenus.

Actinomyces muris ratti Licake. (Streptothrix ratti Schottmüller, Dermat. Wochnschr., 58, 1911, Supplement, 77; Streptathrix muris-ratti Dick and Tunnicliff, Jour Inf. Dis , 23, 1918, 186; Lieske, Morphol. u. Biol. d. Strahlenpilze, Leiprig, 1921, 31; regarded as identical with Streptobacillus monttiformis Levaditi. Nicolau and Poincloux, Compt. rend. Acad Sci. Paris, 180, 1925, 1188 by Topley and Wilson, Princip. of Bact, and Immun., 2nd ed., 1936, 271. The latter organism is regarded as identical with Harcrhillia multiformis Parker and Hudson, Amer. Jour. Path., 2, 1926, 357 by Van Rooyen, Jour. Path. and Bact., 45, 1938, 469; Actinomices muris Topley and Wilson, loc, cit ) From a case of rat-bite fever.

Actinomyces musculorum Hertwig, (Actinomyces musculorum suis Duneker, Etschr I. Microskopieu Fleischheselnau, 5, 1884, No. 3, Hertwig, Arch. f. wissensch. n. prakt Thietheilk., 12, 1886, 365; Osspora musculorum suis Lchmann and Neumanu, Itakt. Diag., 1 Aufl., 2, 1896, 383) Seen in calcarcous deposits in the muscles of swine.

Actinomyces myricae Peklo. (Cent. f. Bakt., 11 Abt., 27, 1910, 451.) From the roots of Myrica.

Actinomyces from Neddeni, Namysłonski. (Cent f. Bakt, I Abt., Orig., 62, 1012, 654.) From the human cyclid. Actinomyces nigricans Killian and Fehér. (Ann Inst. Past., 55, 1935, 620.) From desert soil.

Actinomyces nigrificans (Krüger) Wol-

lenweber. (Oospora nigrificans Krüger, Berichte der Versuchsstat. f. Zuckerrolus, Kergok-Legal, 1890; Wollenweber, Arb. Forschungsinst. für Kartoffelbau, 1920, 16.) From potato seab.

Actinomyces mitrogenes Sartory, Sartory, Meyer and Walter. (Bull. Acad. Med., Paris, 116, 1936, 186; also Ann. Inst. Past., 58, 1937, 681.) From sputum.

Actinomyces nirca. (Incorrectly attributed to Krainsky, 1914 by Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 270.)

Actinomyces nondiastaticus Bergey et als (Var. b. Bergey, Jour. Bact., 4, 1919, 301; Bergey et al., Manual, 1st ed., 1923, 371.) From air.

Actinomyces ochraceus Neukirch. (Ueber Actinomyceten, Strassburg, 1902,

4.) From soil.
Actinomyces ochroleucus Neukrich.
(Ueber Actinomyceten, Strassburg, 1902.

4.) I'rom soil. Actinomyces odorifera Koelz. (Insug Diss., Kiel, 1934; Le Lait, 16, 1936, 154.) Actinomyces oligocarbophilus Lantzsch. (Lantzsch, Cent. f. Bakt., II Abt., 57, 1922, 309; Proactinomyces oligoearbophi-Ina Krassilnikov, Bull, Acad. Sci., U. S. S. R., No. 1, 1938, 139.) Lantzsch regards this organism as identical with Bacillus oligocarbophilus Beijerinck and Van Delden, Cent. f. Bakt., Il Abt., 10, 1903, 33 (Carboxydomonas oligocarbophila Orla-Jensen, Cent. I. Bakt., II Abt., 23, 1909, 311). Secures growth energy by oxidizing CO to COs. From soil. See Manual, 5th ed., 1939, 81 for s description of the bacillary stage of this organism. Carboxyodomonas oligocarbophila Orla-Jensen is the type species of the genus Carboxydomonas Orla-Jensen (loc. cit.).

Actinomyces orangica-niger. (Quoted from Lieske, Morphol. u. Biol. d. Strahlennilze, Leipzig, 1921, 33.)

Actinomyces orangicus. (Quoted from Liesko, Morphol. u. Biol. d. Strahleupilze, Leipzig, 1921, 33.)

Actinomyces pelogenes Sawjalow.

(Cent. f. Bakt, II Abt, 59, 1913, 440) From mud containing hydrogen sulfide.

Actinomyces pluricolor Terni. (Streptothriz pluricolor Fuchs; Terni, quoted from Gasperini, Cent. f. Bakt., 16, 1894, 684, Nocardia pluricolor Chalmers and Christopherson, Ann. Trop Med and Parasit., 10, 1916, 2683.

Actinomyces pluricolor diffundens Berestnew. (Insug. Diss., Moskow, 1897; see Cent f Bakt., I Abt., 24, 1898, 708.) From air.

r rom an

Actinomyces praecox Millard and Burr (Ann. Appl Biol., 13, 1926, 601) From scab on potato

Actinomyces praefecundus Millard and Burr. (Ann. Appl. Biol., 13, 1926, 601.) From seab on potato and from soil

Actinomyces protes (Schurmayer)
Ford. (Oospora proteus and Streptothrix
proteus Schurmayer, Cent. 1 Bakt., I
Abt., 27, 1900, 53; Ford, loc. cit., 208.)
From an abscess of the foot

rom an abscess of the foot

Actinomyces pseudotuberculosae (Flexner) Brumpt. (Streptolhrux pseudotuberculosa Flexner, Jour. Exp. Med., 3, 1893, 433; Brumpt, Précis de Parasit, Paris, 4th ed., 1927, 1206)

Actinomyces pesudotuberculosus Lehmann and Neumann. (Actinomyces atypice pseudotuberkulosu Hamm and Keller, Cent I. Bakt, I Abt, Ref, 42, 1909, 729; Lehmann and Neumann, Bakt. Dias, 5 Aufl, 2, 1912, 621, Nocardan pseudotuberculosis de Mello and Fernandes, Mem Asiatie Soe Bengal, 7, 1919, 110)

Actinomyces purpureus Killian and Fehér (Ann Inst. Part, 55, 1935, 629)

From desert soil.

Actnomyces putors (Dick and Tunnicliff) Ford (Streptothra: putors Dick and Tunnichtff, Jour. Inf. Dis. 23, 1918, 183, Ford, Texth of Bact. 1927, 216) From the blood of a putient bitten by a weasel.

Actinomyces pyogenes Lirake (Line neue Streptothriaspecies, Cammiti, Cent. f. Bakt., I Abt., Orig., 44, 1907, 193; Streptothrix pyogenes Chalmets and Christopherson, Ann Trop Med. and Parasit., 10, 1916, 270, Lieske, Morphol u Biol. d. Strahlenpilze, Leipzig, 1921, 32.) From air.

Actinomyces radiatus Namyslovski. (Namyslovski, Cent. f. Bakt. 7. Abt., Orig. e2, 1912, 564; Streptothris radiatus Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 273; Nacardia radiata Vuillemin, Encyclopèdes Mycologique, Paras, 2, 1931, 126. From an infection of the cornea of the human eye.

Actinomyces rosaceus. (Quoted from Laeske, Morphol u. Biol d Strahlenpilze, Leipzig, 1921, 33.)

Actinonyces roseodiastaticus Duché. (Encyclopédie Mycologique, Paris, 6, 1934, 329)

Actnomyces roseus Namyslowski, (Actnomyces sp. Lowensteins Klm. Monatshi. f. Augenheilk , 48, 1010, 185; Namyslowski, Cat. f. Bakt, I. Abt., Org. 62, 1012, 567; not Actinomyces roseus Krainsky, Cent. f. Bakt, II. Abt., 41, 1014, 602; Discomyces roseus Brumpt, Précis de Parasitol., Patis, 3rd ed., 1922, 981)

Actinomyces scharae Kilhan and Fehér. (Ann Inst Past., 55, 1935, 621) From desert soil

Actnomyces salmonicolor Millard and Burr (Ann Appl. Biol , 15, 1926, 601.) From sour soil.

Actinomyces sampsonii Millard and Burr (Ann Appl Biol., 15, 1926, 601.) From seab on potato.

Actnomyces sanguints Rust (Ind. Jour Med Res., 25, 1937, 325.) From the blood of a patient with bronchial pneumonia

Actinomyces saminii Ciferri. (Quoted from Baldacci, Iloll Sez. Ital Soc. Internaz di Microbiol, 9, 1937, 140)

Actinomyces scionii Millard and Burr. (Ann Appl. Biol , 15, 1926, 601.) From scab on potato

Actinomyces aperalis Millard and Burr. (Ann. Appl. Bod., 15, 1926, 601.) From decaying grass.

Actinomyces taraxeri cepapi (Schottmuller) Ford (Streptothrix taraxeri cepapi Schottmüller, Dermat. Wehnschr., 63, 1914, Supplement, 77; Fotd, loc. eil., 196.) From a case resembling rat-bite fever following the bite of a South African squirrel (Tararerus cepapi).

Actinomyces tenuis Millard and Burr. (Ann. Appl. Biol., 13, 1926, 601.) From

scab on potato.

Actinomyces thermodiastaticus Bergey et al. (Var. a, Bergey, Jour. Bact., 5, 1910, 301; Bergey et al., Manual, 1st ed., 1923, 370.) From stomach contents of a rabbit.

Actinomyces thermotolerans Stadler. (Arch f Hyg., 53, 1899, 40.) From milk

and butter.

Actinomyces variabilis Cohn. (Cent. i Bakt, I Abt., Orig., 70, 1913, 301.) From pus in the bladder in a case of cystitis, and from the prostate.

Actinomyces verrucosus Nadson. (Nadson, Die Mikroorganismen als geologiache Faktoren I. Petersburg, 1903; quoted from Dorff, Die Eisenorganismen, Phanzenforschung, Jens, Helt 16, 1934, 43; not Actinomyces verrucosus Adler, 1901, see Nannizzl, in Pollacci, Tratt. Micopat Umana, 4, 1934, 46.) From sea mud Deposits ferric hydroxide about the mycelial threads.

Actinomyces violaceus (Rossi Doria)
Gasperini. (Streptotriz violacea Rossi
Doria, Ann. d. Ist. d'Ig. violacea Rossi
Doria, Ann. d. Ist. d'Ig. aper. d. Univ. di
Roma, I. 1891. 411; Oespora violacea
Sauvageau and Radais, Ann Inst. Past.,
6, 1892, 282; Gasperini, Cent. f. Bakt., 16,
1894. 681; Cladolhriz violacea Mascó,
Traité Pratique de Bact., 4th ed., 1991,
1075; Nocardia violacea Chalmers and
Christopherson, Ann. Trop. Med. and
Parasit., 10, 1916, 270; Discompces violacea
Brumpt, Précis de Parasitol., Paris,
3rd ed., 1922, 993; From air and water.
Actinomyces viradis (Lombardo-Pelle-

grino) Sanfelice. (Streptothriz viridis Lombardo-Pellegrino, Riforma Med., 19, 1903, 1965; also see Cent. f. Bakt., I Abt., Ref. 25, 1904, 761; Sanfelico, Cent f. Bakt., I Abt., Orig., 36, 1904, 355.) From soil

Actinomyces viriles Millard and Burr.

(Millard and Burr, Ann. Appl. Biol., 15, 1926, 601; not Actinomyces viridis Sanfelice, Cent. f. Bakt., I Abt., Orig., 35, 1904, 355; not Actinomyces viridis Duché, Encyclopédie Nycologique, Paris, 6, 1934, 311.) From scab on potato.

Actinomyces xanthostromus Wollenweber. (Arb. Forschungsinst, f. Kar-

toffelbau, 1920, 16.)

Actinomyces wedmorensis Millard and Burr. (Ann. Appl. Biol., 13, 1926, 601.) From peat soil.

Astroides lieskey! Puntoni and Leonardi. (Boll. e Atti d. R. Accad. Med. di Roma, 61, 1935, 94.) A renaming of Actinomyces lieskey, a culture whose source was unknown. This may possibly be the same as Actinomyces lieskei. Duché (see Streptomyces lieskei).

Cladothriz odorifera Rullmann. (Rullmann, Inaug. Dies., Munich, 1895; eec Cent. f. Bakt., I Aht., 17, 1895, 884 and Cent. f. Bakt., I Aht., \$1, 1895, 884 and Cent. f. Bakt., II Abt., \$, 1895, 116; Oospora odorifera Lehmann and Neumann, Bakt. Diag., 1 Aufl., \$, 1895, 309; Actinomyces odorifer Lachner-Sandoval, Ueber Strahlenpilee, 1895, 65; Strephothriz odorifera Foulerton and Jones, Trans. Path. Soc. London, 65, 1902, 112; Nocardia odorifera Castellani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 818.) From aputum in a case of chronic

bronchitis.

Cladothrix placoides Kligler. (Leptothrix placoides alba Dobrsyniecki, Cest. I. Bakt., I Abt., £1, 1807, 225; Kligler. Jour. Allied Dontal Soc., D, 1915, 141, 282 and 445; Leptotrichia placoides Bergey et al., Manual, 3rd cd., 1939, 458.) From a tooth canal. For a description of this species see Manual, 5th ed., 1939, 829. The description indicates that this organism belongs to Nocardia or Streptomyces.

Coccobacillus pseudo - actinomycosis polymorphus Berestneff. (Berestneff, 1898, quoted from Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 273)

Cohnistreptothrix americana Chalmets and Christopherson. (Streptothrix sp. Bloomfield and Bayne-Jones, Johns 11opkins Hosp. Bull. 26, 1915, 230; Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 273; Actinomuces americanus Dodge, Medical Mycology, St. Louis, 1935, 716) From a liver abscess.

Cohnistreptothrix mieri Carpano (Riv. di Parasit., No. 2, 1937, 197.) From human dermatosis in Egypt

Cohnistreptothrix silberschmidtis Chalmers and Christopherson. (Streptothriv, Silberschmidt, Cent. f. Bakt., I Abt., 27, 1900, 486, Chalmers and Christopherson, Ann Trop Med. and Parasit., 10, 1916, 273, Nocardia silberschmidti Froilano de Mello and Fernandes, Mem. Asiatle Soc. Bengal, 7, 1919, 111; Actinomyces silberschmidti Dodge, Medical Mycology, St Louis, 1935, 711 ) From cases of dacryocystitis.

Discomuces decusseius Langeron and Chevallier. (Langeron and Chevallier, Compt. rend. Sec. Biol . 72, 1912, 1030; Nocardia decussata Castellant and Chalmers, Man. Trop. Med., 2nd ed., 1913, 817: Oospora decussata Sartory, Champ. Paras. Homme et Anim., 1923, 825; Actinomuces decussatus Brumpt, Précia de Parasitol., 4th ed , 1927, 1206.) From dry, scaly lesions. Not considered pathogenic

Nocardia chalmerst de Mello and Fernandes. (De Mello and Fernandes, Mem Asiatic Soc. Bengal, 7, 1919, 130; Actinomyces chalmersi Dodge, Medical Myeology, St. Louis, 1935, 734.) From the saliva of a horse,

Nocardia christophersoni de Mello and Fernandes. (De Mello and Fernandes, Mem Asiatic Soc. Bengal, 7, 1919, 130; Actinomyces christophersoni Dodgo, Medreal Mycology, St. Louis, 1935, 723.) From the air.

Nocardia citrea Chalmers and Christopherson. (Ann. Trop. Med. and Parasit., 10, 1016, 270.) A blanket name proposed to include Actinomyces griscofarus Lirainsky, Actinomyces flarus Kralusky, Streptotheix flara Sanfelice and Streptothriz flara Brung.

Nocardia cruoris Mache and Ingram. (Mache and Ingram, Ann. Trop. Med. and Parasit., 15, 1921, 283; Discomyces cruoris Brumpt, Précis de Parasitol., Paris, 3rd ed., 1922, 984; Oospora cruoris Sartory, Champ. Paras. Homme et Anim . 1923, 809; Actinomyces cruoris Brumpt, sbid., 4th ed., 1927, 1195.) From blood.

Nocardia dichotoma (Macé) Chalmers and Christopherson. (Cladothrix dichotoma Macé, Compt. rend. Acad. Sci. Paris, 6, 1888, 1622; not Cladothriz dichotoma Cohn. Beitr. z. Biol d. Pflanzen 1, Heft 3, 1875, 185; Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 270.)

Nocardia ferruginea Trevisan. (Bakterium bei Chorea St. Viti, Naunyn, Mittheil, aus der Med. Klinik zu Königsberg, 1888, 202; Trevisan, I generi e le specie delle Batteriacce, 1889, 9, Actinomyces ferrugineus Gasperini, Cent. f. Bakt., 15, 1894, 681 ) From pia mater in a case of St. Vitis' dance.

Nocardia gartent (Brumpt) Castellani and Chalmers. (Cladothriz liquefairens No. 2. Garten, Deutsel e Ziechr. f. Chirurg., 41, 1865, 402; Discempees garteni Brumpt, Précis de Parasitol. Patis, 1st ed., 1910, \$60; Castellari and Chairers, Man. Trep. Med., 2rd cd., 1913, 818; Oospora garten: Eartery, Champ. Paras. Homme et Anim., 1923, 778; Actinumyces gurteni Brumpt, loe. cit., 4th ed., 1927, 1191; Actinomyces liquefacions Ford, Textb. of Bact., 1927, 202.) From cases of human actinomycosis.

Nocardia goensis de Mello and Fernandes. (De Mello and Fernandes, Mem Asiatic Soc. Bengal, 7, 1919, 130; Actenomyces poensis Dodge, Medical Mycology, St. Louis, 1935, 723 ) From lesions of vitiligo. Saprophytic.

Nocardia liguire Urizer. 1901; Actinompres liguire Nannizzi, in Pollacci, Tratt. Micopat. Umana, 4, 1931, 49.)

Nocardia liquefaciens (Ilease) Castel.

lani and Chalmers. (Cladothriz liquefaciens Hesse, Doutsche Ztschr. f. Chirurg., 41, 1895, 432; Dinconyces liquefaciens Brumpt, Précis de Parasit., Paris, 1st ed., 1910, 800; Castellani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 816; Streptothriz liquefaciena Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1915, 233, 265; Oospora liquefaciens Sartory, Champ. Paras. Homme et Anim., 1923, 778; Actinomyces liquefaciens Brumpt, loc. cit., 4th ed., 1927, 1192.) From an inguinal absecss.

Nocardia microparva Chalmers and Christopherson. (Ann. Trop. Med. and Parasit., 10, 1916, 263.) Listed as synonymous with Actinomyces microparva Krainsky, 1914 which may be intended for Actinomyces microflaws Krainsky, Cent. f. Bakt., II Abt., 41, 1914, 662.

Nocardia orangica (Berestaeff) Chalmers and Christophetson. (Sireptohrizorangica Berestneff, Inaug. Diss., Moscow, 1897, quoted from Chalmers and Christophetson, Ann. Trop. Med. and Parasit. J 0, 1910. 271: Chalmers and

Christopherson, udem.]
Nocardia rogers de Mello. (Nocardia (Cohnistreptothriz) rogersi de Mello, A Med. Contemp., 1919; Discomyes rogersi Neveu-Lemaire, Précis Parasitol. Hum., 6th ed., 1921, 44; Actinomyes rogersi Brumpt, Précis de Parasitol, 4th ed., 1927, 1206) From sputum.

Nocardia rubea Chalmers and Christopherson (Ann Trop Med and Parasit, 10, 1916, 271) Nomen audum According to Dodge (Medical Mycology, St. Louis, 1935, 765), this is a synonym of Dospora rubra Wilbert, Recueil Hyg. Méd. Vét. Militaire, 1908.

Nocardia saprophytica Chalmers and Christopherson. (Streptothriz twee saprophytica Foulerton, 1902, quoted from Chalmers and Christopherson, Ann Trop. Med. and Parasit, 10, 1916, 270; Chalmers and Christopherson, udem.)

Nocardia urinaria Pijper. (Pijper,

1918, quoted from Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 1057; Actinomyces urinarius Nanniri, in Pollacci, Tratt. Micopat. Umana, 4, 1934, 50)

Oospera hoffmanni (Gruber) Sauvageau and Radais. (Mikromyces hofmanni (sic) Gruber, Trans. Int. Congr. Hyg. Derm., VI, 2, 1891-1892, 65 and Arch. f. Hyg., 16, 1893, 35; Sauvageau and Radais, Ann. Inst. Past., 6, 1892, 251; Actinomyces hoffmanni Gasperini, Cent. f. Bakt., 15, 1894, 684; Streptothriz hofmanni Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 62; Clado. thriz hoffmanni Mscé, Traité Pratique de Bact., 4th ed., 1901, 1081; Nocardia hoffmanni Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 268.) From a sample of vaccine. .

Oospora spumalis Sartory. (Sartory, in Sartory and Bailly, Mycoses pulmonaires, 1923, 318; Actinomyces spumalis Dodge, Medical Mycology, St. Louis, 1935, 751.) From human sputum.

Streptothriz aaser Johan-Olsen. (Inaug. Diss., Christiania, 1893, 91; quoted from Neukirch, Ueber Actinomyceten, Strassburg. 1902, 69.)

Streptothriz alpha Price-Jones. (Price-Jones, 1900; quoted from Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 270.) Considered synonymous with Streptothriz alba (Rossi Doris).

Streplothriz aquatilis Johan-Oleen. (Inaug. Diss., 1893, 93; quoted from Johan-Olsen, Cent. f. Bakt., II Abt., 2, 1897, 279.)

Streptothriz beta Price-Jones. (Price-Jones, 1900; quoted from Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1915, 270; Nocarda beta Chalmers and Christopherson, idem.)

Streptothriz chondri Johan Olsen. (Inaug. Diss., 1893, 95; quoted from Johan Olsen, Cent. f. Bakt., II Abt., 5, 1897, 278.)

Streptothriz enteritidis Pottien. (Quoted from Sanfelice, Cent. f. Bakt., I Abt., Orig , 56, 1904, 355.) Streptothriz foerateri Gasperini. (Gasperini, Annales de Micrographie, 2, 1890, 462, not Streptothriz foerateri Cohn. Beitr. z. Biol. d. Pflancen, I. Heft 3, 1875, 196; Actinomyces aprophyteus Gasperini, Ann. d. Ist. d'Ig. sper. d. Univ. Roma, 2, 1892, 256; Actinomyces aprophyticus var. cromogenus Gasperini, ibid. 220). From air.

Streptothriz gelatinosus Johan-Olsen. (Cent f. Dakt., II Abt., 3, 1897, 279.) Streptothriz humfica Johan - Olsen (Cent. f. Bakt., II Abt., 3, 1897, 278.) Streptothriz lemani Johan-Olsen. (Inaug. Diva., 1893, 98; quoted from Johan-Olsen, Cent. f. Bakt., II Abt.,

5, 1897, 279.)
Streptothriz necrophora Wilhelm.
(Monats. f. prakt. Tierheilk., 14, 1902,
193 ) See page 578

Streptothrix leucea Foulerton. (In Allbutt and Rolleston, Syst. of Med, 2, 1912, 310)

Streptothriz melanotica Price-Jones-(On the General Characteristics and Pathogenie Action of the Genus Streptothriz, 1901; also see Foulerton, in Alibutt and Rolleston, Syst. of Med., 2, 1912, 301.)

Streptothrix ordieformis Johan-Olsen.

(Inaug. Diss, 1893, 96; quoted from Neukireh, Ueber Actinomyceten, Strassburg, 1902, 69)

Streplothriz spirilloides Johan-Olsen (Innug. Diss., 1893, 96; quoted from Neukirch, Ueber Actinomyceten, Strassburg, 1992, 69.)

Streptothrix tartari Sanfelice. (Cent. f. Bakt., I Abt., Orig., 36, 1904, 355.)

Streptothriz wallemia Johan-Olsen. (Inaug Diss., 1893, 96; quoted from Neukireh, Ueber Actinomyeeten, Strassburg, 1902, 69.)

Streptothriz zopfi Casagrandi. (Quoted from Caminiti, Cent. f. Bakt., I Abt., Orig. 44, 1907, 198.)

Drechaler (Botan, Garette, 67, 1919, 65 and 147) described eighteen morphological types of Actinomyces (Stephomyces). The relationships of these types to apecies previously described in the literature are not explained everpt in four instances. Actinomyces III is regarded as Actinomyces arendulae Wahsman and Curtis; Actinomyces X is regarded as Actinomyces arendulae Subsaman and Curtis; Actinomyces XII is regarded as Actinomyces XII is regarded as Actinomyces with the Actinomyces XII is regarded as Actinomyces and Curtis; and Actinomyces XVII is Actinomyces scales Gussow.

# Genus II. Micromonospora Ørskov.

(Orskov, Investigations into the morphology of the ray fungi. Copenhagen, 1923, 147; includes Thermoactinomyces Tsilinsky, Ann. Inst. Past., 13, 1899, 501; ibid.,

17, 1903, 206.)

Well developed, fine, non-septate mycelium, 0.3 to 0.6 micron in diameter. Grow well into the substrate. Not forming at any time a true aerial mycelium. Multiply by means of conidia, produced singly at end of special conidiophores, on surface of substrate mycelium Conidiophores short and either simple, branched or produced in clusters. Strongly proteolytic and diastatic. Many are thermophilic and can grow at 65°C. Usually saprophytes. These organisms occur mostly in hot composted manure, dust, soil and in lake bottoms.

The type species is Micromonospora chalcea (Foulerton) Orskov.

## Key to the species of genus Micromonospora (Orskov Group III).

- I. Vigorously growing organisms, typically with copious spore formation on glucoseasparagine-agar.
  - A. Vegetative mycelium pale pink to deep orange, no typical soluble pigment. 1. Micromonospora chalcea.
  - B. Vegetative mycelium orange changing to brownish-black, brown soluble pigment.

2. Micromonospora fusca.

- II. Slowly and feebly growing organisms, with scant spore formation on glucoseasparagine-agar, no soluble pigment.
  - A. Vegetative mycelium pale pink to pale orange.
  - 3. Micromonospora parva. B. Vegetative mycelium yellow to orange-red.
    - 4. Micromonospora globosa.
  - C. Vegetative mycelium blue.
    - 5. Micromonospora vulgaris.

Note: This genus could be subdivided on the basis of the relations of the organisms to temperature, since it includes a number of thermophilic forms which grow readily at 55° to 65°C, mesophilic forms having their optimum temperature at 30°C, and organisms growing at low temperatures in lakes. Each of these can be divided into 3 groups, based on the structure of the spore-bearing hyphae. Among the thermophilic forms, only representatives of the first group have so far been isolated in pure culture although the existence of the other two groups has definitely been demonstrated in microscopic preparations. These are:

Group 1. Simple spore-bearing hyphae.

Group 2 Branching spore-bearing hyphae.

Group 3. Spore-bearing hyphae in clusters.

1. Micromooospora chalcea (Foulerton) Orskov. (Streptothriz chalcen Foulerton, Lancet, 1, 1905, 1200, Nocardia chalcea Chalmers and Christopherson, Ann. Trop Med and Parasit., 10, 1916, 263; Orskov, Thesis, Copenhagen, 1923 156; Actinomycea chalcea Ford, Textb of Bact., 1927, 221.) From Greek chalceus, bronze.

Description from Jensen, Proc. Linn. Soc New So. Wales, 57, 1932, 173.

Formation of a unicellular mycelium which forms distally placed, singly situated spores No serial hyphae. No surface growth in liquid mediure The organism resists desiccation for at least 8 months. Comparison between the power of resistance of the mycelium and the spores, respectively, will no doubt present great difficulty, because it is almost impossible to ensure that the two constituents are actually detached Otherwise, the mycelium is but slightly capable of germinating, which may be ascertained by inoculating a water agar plate liberally with a mixture of mycelial threads and spores. While practically all the spores germinate, the mycelial threads were never found to form new colonies.

Vegetative mycellum on glucosc-asparagine-agar: Heavy, compact, raised, pale pink to deep orange, not spreading much into the medium. Spore-layer well developed, moist and glistening, brownish-black to greenish-black, this color sometimes spreading through the whole mass of growth.

Gelatin is liquefied.

Grows in liquid media as small firm numge granules or flakes

Milk is digested with a faintly acid reaction, mostly after a previous congula-

Many stmins invert sucrose
Some strains produce nitrates from

Starch is hydmlyzed

Most strains decompose cellulose Proteolyticactionscementronger in this

than in the other species of this genus
Optimum temperature for growth 30°
to 35°C Thermal death point of mycelium, 70°C In 2 to 5 minutes
Fores
resist 80°C for 1 to 5 minutes.

Habitat 'Soil, like mud and other substrates in addition to the above references, see Erikson (Jour Beel, 41, 1911, 201) and Unbreit and McCoy (A Symposium on Hydrabiology, Univ of Wisconsin Press, 1941, 106-114).

2 Micromonospora fusca Jensen (Proc. Linn Soc. New So. Wales, 57, 1932, 178.) Fmm latin fuscus, dark. Vegetative mycelium on glucose-asparagine-agar heavy, compact, orange, rapidly changing to deep hrown and nearly black; spore-layer moist, glistening, grayish- to brownish-black. Deep brown solubbe pigment.

Getatin is liquefied.

Grows in liquid media as small brown granules and flakes.

Milk is slowly digested; no coagulation. Sucrose 13 inverted.

Reduction of nitrates, positive or negative.

Cellulose is attacked to a slight extent. Starch is hydrolyzed.

Habitat : Soil.

 Mieromonospora parva Jensen.
 (Proc Lann. Soc. New So Wales, 57, 1932, 177) From Latin parcus, small.

Scant growth on glucose-asparagineagar; vegetative mycelium thin, spreading widely into the egar, almost colorless to pale pink or orange. Sporulation scant, giving rise to thin grayish, moist crusts on the surface

Gelatin is liquefied.

Milk is left unchanged; or coagulated, slowly redissolved with faintly acid reaction

Sucrose not inverted. Nitrates not reduced.

Cellulose not decomposed.

Starch is hydrolyzed Habitat Soil

4. Micromonospora globosa Krassilnikov. (Ilay Fungi and Relited Organisma Itel Acad. Nauk, Moskow, 1938, 131, Microbiology, U. S. S. R., 8, 1939, 179.) From Latin globosus, apherical

A fine (0.5 to 0.8 micron in diameter) monopoldially branching mycelium. This mycelium breaks seen into acprate pieces of varying length and irregular outline. Confida are formed at the end of abort branches, one on each Individual branches with confida resupherical 10 to 1.3 microns; they arise by the

swelling of the branch tips. The swellings become round, acquire the shape of spheres, which, as the formation of the conidia proceeds, are divided from the branch by a transverse sentum.

Gelatin is liquefied.

Colonies: Rugose, at first very compact, later acquire a pasty consistency. and their bond with the medium becomes not so fast. The color of the cultures varies from light yellow to orange-red. During fruit-bearing the colonies are covered with a brownish-black tarnish of conidia.

In meat-pentone broth, ammonia is produced.

Milk · Coagulation: pentonization. Nitrites are produced from nitrates. Sucrose is inverted. Cellulose not decomposed. Starch is hydrolyzed. Habitat: Soil.

5. Micromonospora vulgaris (Tsilinsky) Waksman, Umbreit and Gordon. (Thermophile Cladothers, Kedzior, Arch. Hyg., 27, 1896, 328; Thermoactinomuces pulgaris Tsilinsky, Ann. Inst Past , 13, 1899, 501; Actinomyces monosporus Schutze, Arch. f. Hyg., 67, 1908, 50 (Nocardia monospora Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 271), Actinomyces glaucus Lehmann and Schutze, in Lehmann and Neumann, Bakt Diag , 5 Aufl., 2, 1912. 641 (Nocardia glauca Chalmers and Christopherson, loc. cit.); Micromonospora coerulea Jensen, Proc. Linn. Soc. New Sc. Wales, 57, 1932, 177; Waksman, Umbreit and Gordon, Soil Sci., 47, 1939, 51.) From Latin vulgaris, common.

Morphologically the development of this organism is entirely comparable to that of the mesophilic form described by Jensen. The young mycelium shows slightly more branching than that produced by species of Streptomyces. Spores are borne at the end of short branches from which they are casily broken. The aerial mycelium, though present, is usually rudimentary, rarely exhibiting the tangled network of strands

typical of species of Streptomyces. Thermophilic strains of Micromonoscora rulgaris differ thus from the mesophilic forms, which show no trace of serial mycelium. Fragmentation has not been seen in slide cultures of the organism thus far isolated, but it was found to occur in smear preparation.

According to Jensen, the mesophilic strains grow slowly on glucose-asperagine-agar; vegetative mycelium dense. dark greenish-blue, with a hard and glossy surface. Sporulation very scant. The surface sometimes shows a thin white veil resembling serial mycelium, but without aerial spores.

Gelatin: Liquefaction.

Good growth on beef peptone agar, potato, milk, beef-peptone broth, etc. Grows in liquid media as fairly large, firm, round, white to pisk granules (Jensen). Usually a white, powdery, thin aerial mycelium is produced which is hardly raised above the surface. No soluble pigment is formed.

Czapek's sgar : Growth white, powdery,

elightly raised.

ture composts.

Broth: A tough white pellicle and ia many instances a considerable number of ball-like colonics at the bottom of the tube. No turbidity.

Milk: Coagulated and digested. Nitrites not produced from nitrates.

Sucrose not inverted.

Cellulose not decomposed.

Starch is hydrolyzed. Optimum temperature of thermophilic forms 57°C. Growth range 48° to 68°C. Habitat: Straw, soil, high tempera-

Appendix: The following anaerobic

species has been described:

Micromonospora propionici Hungate. (Abst. in Jour Bact., 48, 1944, 380 and 499; Jour Bact., 51, 1946, 51.) From the alimentary tract of the wood-eating termite (Amitermes minimus). Ferments glucose or cellulose to form acctic and propionic acids and CO2. Obligate anaerobe.

#### ORDER III. CHLAMYDOBACTERIALES BUCHANAN.

(Jour. Bact., 2, 1917, 162.)

Filamentous, colorless, alga-like basteria. May or may not be ensheathed. They may be unbranched or may show false branching. False branching arises from a lateral displacement of the cells of the filament within the sheath which gives rise to a new filament, so that the sheath is branched while the filaments are separate. The sheath may be composed entirely of iron hydroude, or of an organic matrix impregnated with iron, or may be entirely organic. The filaments themselves may show motifity by a gliding movement like that found in the blue-green algae (Osnidia toriacce). Condia and motife fiagellate swarm cells may be developed, but never endospores. Fresh water and marine forms.

### Key to the families of order Chlamydobacterlales.\*

- I Alga-like filaments which do not contain sulfur globules False branching may occur.
  - A Usually free floating filaments Motile swarm cells may be formed.

    Family I Chlamydobacteriaceae, p. 981
  - B Attached filaments which show a differentiation of base and tip Non-motile conidia formed in the swollen tips of the filaments
- Family II Crenothrichaceae, p 987.

  II Alga-like, unbranching filaments which may contain sulfur globules when growing in the presence of sulfades. Filaments may be motile by a creeping or shiding movement along a solid substrate

Family III Reggiatoaceae, p. 988.

### FAMILY I, CHLAMYDOBACTERIACEAE MIGULA.\*\*

(Arb. Bakt. Inst. Hochschule, Karlsruhe, 1, 1891, 237)

l'ilamentous bacteria which frequently show false branching Sheaths may or may not be impregnated with ferric hydroude. Cells divide only transversely. Swarm cells, it developed, are usually moute by means of flagella Usually found in fresh water

### Key to the genera of family Chlamydobacteriaceae,

- I Showing typical false branching
  - A Sheaths entirely organic, not impregnated with ferric hydroxide Genus I Sphaerotilus, p 982
    - B. Sheaths impregnated with ferric bydroxide
- Genus II Clonothrix, p 983.
- Unbranched or rarely showing false branching
   A. Sheaths or holdfasts impregnated with letric hydroxide
   Genus III Leptothras, p. 983

<sup>•</sup> In Appendix 1, p. 906, will be found a group of non-filamentous, non-sheath-forming, coloriers sulfur bacteria, as the family Achromaticence. Their true relationships are as yet obscure, and they have been attached as an Appendix to the CHomy lobacteriales largely on account of the similarity of their metabolism to that of the Begintonceae.

<sup>\*</sup> Completely revised by Prof. A. T. Henrici, University of Minnesota, Minneapolis, Minnesota, December, 1935; further revision by Prof. Robert S. Breed, New York State Layeriment Station, Genera, New York, July, 1916.

## Genus I. Sphaerotilus Kūtzing. (Kutzing, Linnaea, 8, 1833, 385; Cladothrix Cohn. Beitr. z. Biol. d. Pfianz., 1.

Attached, colorless threads, showing false branching, though this may be rare in some species. Filaments consist of rod-shaped or ellipsoidal cells, surrounded by a firm sheath. Multiplication occurs both by non-motile conidia and by motile swarm cells, the latter with lophotrichous flagella.

The type species is Sphaerotilus natans Kutzing.

Heft 3, 1875, 185 ) From Greek sphaera, sphere.

 Sphaerotilus nstans Kutzing. (Kutzing, Linnaen, 8, 1833, 385; not Sphacrotilus natans Sack, Cent. I. Bakt .. II Abt , 65, 1925, 116; Cladothrix natans Migula, in Engler and Prantl, Die natürl Pflanzenfam. 1, 1a, 1895, 46.) From Latin natans, swimming.

Cells cylindrical, surrounded by a sheath which is slimy in character, 2 to 3 microns in diameter. False branching

Multiplication occurs through the formation of conidia within the sheath of the vegetative cella, from which they swarm out at one end, swim about for a time, then attach themselves to objects and develop into delicate filaments

Gelatin rapidly liquefied. requires organic nitrogen, does not grow in the ordinary peptone solution, grows best with low concentrations of meat extract (Zikes, Cent f. Bakt , II Abt., 45, 1915,

The culture cultivated and described as Sphaerotilus natans by Sack (Cent. f Bakt , II Abt , 65, 1925, 116) was identified as Bacillus mycoides by Hang (ibid .

69, 1926, 4)

Source Originally found in polluted waters. May become a real nuisance in sewage purification plants of the activated sludge type (Lackey and Wattie, U. S. Pub. Health Ser., Pub Health Repts., 55, 1940, 975) and in streams polluted with sulfite liquor from pulp and paper mills (Lackey, Mimeographed Rept. U. S Pub. Health Ser , 1941).

Habitat: Stagnant and running water, especially sewage polluted streams.

Sphserotilus dichotomus (Cohn) Migula. (Cladothrix dichotoma Cohn,

Beitr. z. Biol, d. Pflanz., 1, Heft 3, 1875, 185; Migula, Syst. d. Bakt., 2, 1900, 1033; Sphaerotilus natans var, cladothrix Butcher, Trans. Brit, Myc, Soc., 17, 1932, 112.) From Greek dichotomos, cut in two parts, forked.

The identity of this species as distinct from Sphaerotilus natans has been questioned. Cohn's description applied to filaments 03 micron in diameter, while all later authors have applied the name to a much larger organism (2 to 4 microns

in diameter).

Zikes (Cent. f. Bakt., II Abt., 43, 1915, 529) gives the following differential characters: Cells smaller than Sphaerotilus natans, 1.5 to 2.5 microns; false branching constant; grows best in high concentrations of meat extract; will grow in ordinary peptone solutions; can utilize inorganic nitrogen; liquefies gelatia slowly

Source · Found by Cohn in water containing Myconostoc.

Habitat. Comparatively unpolluted fresh water capable of sustaining algae. .

 Sphaerotilus fluitans (Migula) Schikora. (Streptothrix fluitans Migula, in Pflanzen.

fluitans Migula, Syst d Bakt., 2, 1900, 1033; Leptothrix fluitans Chester, Man. Determ. Bact., 1901, 370 ) From Latin flustans, flowing, floating.

Very thin attached filaments surrounded by a soft sheath, from which almost spherical conidia issue, usually attaching themselves to the exterior of the sheath, where they multiply.

Habitat, Swamp water or sewage polluted waters

Appendix: Additional species have been described as belonging in this genus. Those described by Ravenel have generally been overlooked although he was one of the earliest workers to culture these exercises. The last follows.

these organisms. The hst follows-Claddhrix fungiorms Ravenel. (Mem Nat Acad. Sci., 8, 1896, 19) From deep virgin soil

Cladothrix intestinalis Ravenel (loc. ett., 18) From virgin soil.

Cladothrix non-liquefaciens Ravenel

(loc. cit, 16). From deep made soil.

Cladothrix profundus Ravenel (loc cit., 17). From deep made soil.

Cladethrix ramesa Gasperini. (Atti d Soc. tescana d'Ig, 2, 1912, 000)

From water.

Cladothriz reticularis Naumann (Kugl. Svenska Vetenskapsakad Handl., I, 62, Part 4, 1921, 44; Sphaerotilus reticularis Cataldi, Thesis, Univ. Buenos Aires, 1939, 55.) From Aneboda region. Saeden.

Sphaerotilus roseus Zopf. (Beiträge z Physiol, u. Morph, nieder. Organis-

men, 1892, 32.) From water,

#### Genus II Clonothrix Roze.

(Jour d Bot , 10, 1896, 325.) From Greek lion, a twig and thriz, hair. Attached filaments showing false branching as in Sphaerotilus. Sheaths organic,

the younger portion of the filaments
The type species is Clonothriz fusca Roze.

1 Clonothrix fusca Roze. (Roze, Jour d. Bot., 10, 1820, 325, Clonothrax fusca Schorler, Cent. f Bakt, II Abt., 12, 1901, 689, Crenothrax fusca Dorfl, Due Fluenorganismen. Pflanzenforschung, lifelt 16, 1934, 41) From Latin fuscus, brown

Colls cylindrical with rounded ends, 2 by 10 microns, becoming larger toward the base and smaller toward the tips of the filaments

Shorths 7 microus at the base to 2 microns at the tips

Condis about 2 microus in diameter. This organism was described by Rom as a blue green alga, but subsequent observers have failed to find picment. It was described independently by Schorler who give it the same name Cheledny considered it identical with Cermolary polypoor but Kolk (Amer.

Jour. Bot , 25, 1938, 11) has clearly differentiated these species.

Habitat. Waterworks and pipes.

Appendix: Apparently the following species resemble Clonothrix fusca:

Clonchrax tenus Kolkwitz. (Kolkwatz. Schizomycetes in Kryptogamenflors der Mark Brandenburg, 5, 1915, 141, Crenothriz tenuis Dorff, Die Eisenorgansmen. Pflanzenforschung. Het 16, 1931, 42) From the settling bysin of a sewage plant near Berlin. Dorff thinks this may have been a growth form of Crenothric Jusca Dorff

Mycothrix abundans Naumann. (Kungl. Svenska Vetenskapsakad. Handl 1, 62, 1921, Part 4, 44.) From the Aneboda region, Sweden. The type species of the genus Mycothrix.

Uycothriz elonotricoides Naumann (loc est., 54). I'rom the Aneboda region, Sweden

#### Genus III. Lepiothrix Kutzing.

(hützing, Phycologia Generalis, 1813, 198, not Leptotrichia Trevisan, Reale Ist. Lombardo di Sci. e Lettere, Ser. 2, 12, 1579, 139, Detoniella DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 6, 1889, 929; Chlamydothrix Migula, Syst. d. Bakt., 2, 1900, 1030; Conidiothriz Benecke, Bau u. Leben d. Bakt., 1912, 489; Megalothriz Schwers, Cent. f. Bakt., II Abt., \$3, 1912, 273; Syncrotis Enderlein, Sitzber. Gesell. Naturf. Freunde, Berlin, 1917, 312.) From Greek leptos, small and threx, bair.

Filaments of cylindrical colorless cells, with a sheath at first thin and colorless. later thicker, yellow or brown, encrusted with ferric hydroxide. The oxide may be dissolved by dilute acid, whereupon the inner cells show up well. Multiplication is by division and abstraction of cells and by motile cylindrical swarmers. False branching may occur.

The type species is Leptothrix ochracea Kützing.

### Key to the species of genus Leptothrix.

- I. Filaments not spirally twisted.
- A. Free swimming, not attached.
  - 1. Sheath homogeneous, cylindrical,
  - 1. Leptothrix ochracea. 2. Sheath composed of a bundle of fine parallel filaments.
  - 2. Leptothriz trichogenes.
  - B. Attached to a substrate by a holdfast,
    - 1. Arising singly, each filament from its own holdfast.
      - a. Filaments show false branching.
      - 3. Leptothriz discophora,
      - an, Filaments unbranched.
        - 4. Leviothrix sideropous.
    - 2. Numerous filaments arising from a common holdfast. a. Filaments large, uniform in diameter.
      - 5. Leptothrix lopholea.
      - aa. Filaments smaller, tapering toward the tip. 6. Leptothriz echinata.
- II. Filaments spirally twisted.
  - A. Epiphytic, growing twisted around filamentous algae.
  - B. Not epiphytic.
- 7. Leptothriz epiphytica. 8. Leptothrix pseudovacuolata.

ochracea Leptothrix (Kützing, Phycologia Generalis, 1843, 198; Lyngbya ochracea Thuret, Ann. Sci. Nat. Bot., VI, 1, 1875, 279; Beggialoa ochracea Gasperini, Ann. d'Igiene Sper., 2, 1912, 000; Chlamydothrix ochracea Migula, Syst. d. Bakt , 2, 1900, 1031.) From Latin ochra, yellow.

Long filaments, free-floating, never attached to a substrate, never branching. Filaments 1 micron in thickness. composed of rod-like colorless cells, surrounded in young filaments by a deficate sheath which later becomes yellow to brown in color.

Sheath homogeneous, completely dissolving in dilute hydrochloric acid.

When the sheath becomes very thick, the filaments creep out of the sheath and scerete a new one, so that many empty sheaths are found. Polar flagellate, motile, swarm-cells have been observed

Habitat: Iron-bearing waters.

2. Leptothrix trichogenes Choloday. (Choledny, Cent. f. Bakt., II Abt., 61, 1924, 292; Toxolhrix ferruginea Molisch, Die Eisenbakterien in Japan, Sc. Report Tohoku J. Univ., 4 Ser. Biol., 1, 1925, I'rom Greek thrix, hair and geno, producing.

Long, slender, articulated filaments, free-floating, never branched. Filaments 0.5 micron in thickness, composed of rod-like colorless cells.

Filaments surrounded by a fine sheath. This sheath ruptures longitudinally and rolls up as a fine hair-like body at one sade of the filament. This process continually repeated leads to the development of a thick sheath composed of numerous hair-like bodies arranged in parallel bundles, which are easily separated from the filament. The sheath is completely dissolved in dilute hydroshlore acid.

Mode of reproduction is unknown. Habitat: Iron-besting waters.

3 Leptothrix discephora (Schwers)
Dorff. (Megdothrix discephora Schwers,
Cent f. Bikt., II Abt., 35, 1912, 273,
Leptothrix crossa Cholodny, Cent. f.
Bakt., II Abt., 61, 1921, 292, Chlamydothrix discephora Naumann, Ber. d.
Deutsch Bot. Ces., 46, 1923, 411, Dorff,
Die Tissnorgunismen, Pflangenforschung, Ileft 16, 1931, 31.) From Latin
Lagis, disk and Greek phorous, 10 bert.

Long, slender, articulated filaments composed of elements of varying length showing lalss branching (Cholodny, loc cit, 297) Usually nitached to a submerged substrate but may be free-floating.

Tilaments surrounded by a heavy sheath, thick (10 to 15 microns) at the base, tapering toward the free tip, heavily impregnated with ferric hydroxide

Reproduction by mutile awarm cells inherated from the tip, and also by the emergence of the filament from the sheath, with subsequent breaking up into individual non-motile cells (conidia).

Habitat, Water.

4 Leptothrix sideropous (Molisch) Cholodny (Chlamylothriz sideropous Molisch, Die Eisenbakterien, 1910, 14; Gallionella siderpous Naumann, Kungl. Svenska Vetenskapsakad, 62, 1921, 33; Cholodny, Die Eisenbakterien, Pflanzenforschung, Helt 4, 1926, 25.) From Greck sideros, iron.

Short, unbranched filaments composed of rod shaped cells of varying length, 0 6 micron in diameter.

Sheath very thin, colorless, giving an iron reaction only at the base of the filament. Attached by a broad holdlast which gives a marked iron reaction.

Habitat: Found in water, growing on submerged surfaces.

5 Leptothrix lopholea Dorff. (Die Lisenorganismen, Pflanzenforschung, Heft 16, 1934, 33.) From Greek lophoz, erest, tuit.

Short, slender unbranched filaments, uniform in diameter, attached to a substrate, 5 to 13 filaments arising from a common holdfast. Filaments 20 to 33 microns long, cells 0 5 by 1.0 to 1.3 microns.

Sheaths composed of ferric hydroxide dissolve completely in dilute hydro-chloric scid.

Filaments creep out of the sheath as in Leptothriz ochracea. Habitat: Water.

6. Leptothrix echinata Beger. (Cent. f. Bakt., II Abt., 52, 1935, 401.) From Latin cchinatus, bristled.

Similar to the preceding species, but occurring in larger colonies, 20 to 50 filaments arising from a common hold-fast. Filaments are shorter (9 to 10 microns).

Sheath is thicker at the base and tapers toward the free tip of the filsments, which are slightly spiral. The sheath contains an organic matrix visible after treatment in dilute hydrochloric acid.

Habitat: Found in water, especially in manganese-bearing waters.

7. Leptothrix epiphytica (Migula) Chester. (Streptothriz epiphytica Migula, in Engler and Prantl, Die naturl. Pflanzenfam., I, Ia, 1895, 33; Lyngöya epiphytica Hieronymus, in Kirchner, ibid., Gr. Chester, Manual Determ. Bact., 1901, 370; Leptothriz volubilis Cholodny, Cent. I. Bakt., II. Abt., 61, 1924, 292, Chlamydolhriz epiphytica Naumnna, Ber d Deutsch. Bot. Gen., 46, 1923, 141.)
From M.L. epiphyticus, epiphytic.

Long cylindrical unbranched filaments growing spirally around filamenta of Tolypothriz, Oedogonium, etc. Cells rod shaped, 1 by 2 microns.

Sheaths cylindrical, encrusted with iron.

Cells may leave the sheaths as in Leptothrix ochracea

Habitat: Water.

Leptotbrix pseudovacuolata (Perfiliev) Dorff. (Spirothriz pseudovacuolata Perfiliev, Verh. d. Int. Verein. f. theor. u. angew. Limnologie, 1925, Stuttgart, 1927; Dorff, Die Eisenorganismen, Pflanzenforschung, Heft 16, 1934, 36.) From Greck, having false vaeuoles.

Filamentn 85 to 250 microns in length, unbranched, spirally wound, occasionally straight. Strongly encrusted with ferric hydroxide Spirals 20 to 24 microns from crest to crest

Cells rounded at the ends, thin-walled, granular, 1 7 to 2 8 by 3.5 to 30 microns Apparently beterotrophic

Apparently beterotropine
Habitat Found in bottom muds of deep
lakes with very low oxygen content.

Appendix: The following simple, filamentous organisms have also been placed in the genus Leptothrix or appear to belong here.

Chlamydothrix thermalis Molisch (Die Eisenbakterien in Japan. Se. Report Tohoku J Univ., 4 Ser Biol., 1, 1923, 135; Leptothrix thermalis Dorff, Die Eisenorganismen, Pflanzenforschung, Heft 16, 1934, 38) From hot springs in Japan.

Leptothrix hyalina (Migula) Bergey et al. (Streptothrix hyalina Migula, in Engler and Prantl, Die naturl. Pflanzenfam., 1, 1a, 1895, 38; Chlamydothrix hyalına Migula, Syst. d. Bakt., 2, 1900, 1603; Bergey et al., Manual, 1st ed., 1923, 391) Prom snamp water.

Leptothrix major Dorff. (Die Eisenorganismen, Pflanzenforschung, Heft 16, 1934, 35.) From Spree River water near Berlin.

Leptothrix winogradskii Cataldi (Thesis, Univ. Buenos Aires, 1939, 64) From water.

Lieskella bifda Perfiliev. (Perfiliev, Verh. d., internat. Vereinigung f., theoret. u. nngew. Limnologie, 1925, Stuttgart, 1927; quoted from Dorff, Die Eisenorganismen. Pfancenforschung, Helt 16, 1934, 27; also designated Liesleella bifilaris by Perfiliev.) From Iran bearing water. Shows gliding movements similar to blue-green algae. The type species of the sonus Lieskeella Perfiliev.

Sideromyces glomerata Nauman.
(Quoted from Dorff, Die Risenorgansmen, Pflanzenforschungen, Heft 16, 1934, 27.) From swamps in the Aneboda region of Sneden. This is the type species of the genus Sideromyces syn. Mycogodionedia Naumann.

Spherothriz talens Perfiliev. (Perfiliev, Verh. d internat. Vereinigung f. theoret. u. angow. Limnologie, 1925, Stuttgart, 1927; quoted from Dorff, Die Eisenorganismen, Pfansenforschung, Heft 15, 1934, 29) From a peat bog m a small pond near Leningrad. This is the type species of the genus Spharothriz Perfiliev. Grows in disks showing a concentric structure.

#### TAMILY II. CRENOTHRICHACEAE HANSGIRG.\*

(Österr. Bot. Ztschr., 36, 1888, 223.)

Filsments not branched, attached to a firm substrate, showing differentiation of base and tip. Sheaths planely visible, thin and colorless at the tip, thick and encrusted with iron at the base. Cells cylindrical to spherical, dividing in three planes to produce the spherical non-motific condition.

#### Genus I. Crenothrix Cohn.

(Colm, Beitr. z. Biol. d. Pflanz., 1, Heft I, 1870, 108; Phragmidiothriz Engler, Verh. Bot. Ver. Brandenb., 24, 1882, 19) From Greek crenos, spring and thriz, hair. Characters as for the family.

The type species is Crenothriz polyspora Colin.

1. Crenothrix polyspora Cohn (Bestr z Buol d. Pflanz, I, Iflet I, ISTO, 108; Hyphcothriz kuchniana Rabenhorst, Ilora europ algarum, Sect. II, 88; Leptothriz kuchniana Rabenhorst, Algen Sachsens, No 284, Crenothriz kuchniana Zappl, Zur Morphologie der Spaltpilen, 1882, 36, Crenothriz manganifera Jackson, Ilyg Rund 14, 1001, 19) From Greck, many spores.

Long, articulated filaments, unbranched, enclosed in a sheath which becomes expanded toward the tip. The sheath is composed of organic matter cherusted with iron. Plaments, including the sheath, measure 2 to 9 microus in liameter.

Vegetative cells vary markedly in length from long cylindrical to short avoid forms

avoid forms
Conidia, spherical, I to 2 microns in
diameter, are liberated from the ex-

punded tips of the sheaths. They are non-mottle Cultivation Has not been grown on

artificial media in pure culture.

Conidia may germinate upon the ex-

terior of the sheath from which they have been liberated, giving rise to new filaments attached to the surface of the older one, presenting a simulation of false branching.

Cholodny Lelieved Clonothriz Jusca to be identical with Cranothriz polyspora. However, Clonothriz Jusca shows genuine false branching and produces condita by fission in only one plane, so that the filaments taper toward the filaments to condition by fission in only one plane, so that the filaments deeper toward the tipusted of expanding (see Kolk, Amer. Jour. Bot., 25, 1938, 11) for a clear cut differentiation of these two species.

Source This organism is vide-spread in water pipes, drain pipes and springs where the water contains iron. It frequently fills pipes under such circumstances and causes a real nuisance. Found by Cohn in samples of water from springs in the neighborhood of Breslau, Germany.

Habitat In ataguant and running waters containing organic matter and iron salts, growing as thick brownish or greenish masses.

Completely revised by Prof. A. T. Henrier, University of Minnesots, Minneapolis, Minnesota, December, 1938, further revision by Prof. Robert S Breed, New York State Experiment Station Genera, New York, July, 1946.

# FAMILY III. BEGGIATOACEAE MIGULA.

(Arb. Bakt. Inst. Karlsruhe, 1, 1894, 238: in part, Leuco-Thiobacteria Bavendamm, Die farblosen and roten Schwefelbakterien, Pflanzenforschung, Heft 2, 1924, 102.)

Filamentous organisms, composed of chains of cells. Individual cells generally not visible without staining. Structure very similar to that of Oscillatoriaceae, but devoid of chlorophyll and phycocyanin. When growing in the presence of hydrogen sulfide, the filaments contain sulfur globules. Special reproductive structures unknown.

In proposing the family Beggiatoaceae for the two genera of this subgroup known in 1894, Migula remarked that "it would be best to combine them with the Oscillatoriaccae and classify them among the Schizophyta" (Arb. Bakt. Inst. Karlsruhe, 1. 1894, 238). The same authority has stated: "Also in view of their internal structure the species of Begginton are so similar to those in the genus Oscillaria that they can hardly be separated generically" (in Engler and Pranti, Die naturi. Pflanzenfam., 1, 1a, 1895, 41).

Since then, the close relationship between the filamentous, colorless sulfur bacteria ·. · · · ·

toaceae Migula is retained for these filamentous sulfur bacteria. Taxonomicany they could readily be classified as colorless members of the class Schizophyceae.

### Key to the genera of family Beggialoucese.

- I. Filaments non-motile. Grow attached by means of holdfast at base. Genus I. Thiothriz, p. 988.
- II. Filaments motile, like Oscillatoria, by creeping or sliding movements along a solid substrate. Not attached.
  - A. Occurring singly, not embedded in a common slime-sheath.
    - 1. Filaments straight or bent, but not permanently rolled. Genus II. Beggiatua, p. 990.
    - 2. Filaments coiled or spirally wound.

Genus III. Thinspirillopsis, p. 993.

B. Occurring in bundles, embedded in a common slime-sheath. Genus IV. Thioploca, p. 993.

# Genus 1. Thiothrix Winogradsky.

(Beitr. z. Morph. u. Physiel. d. Bakt., I, Schnefelbacterien, Leipsig, 1888,

39.) From Greek theion, sulfur, and thrix, bair.

Filaments non-motile, segmented, with a delicate sheath, and differentiated into base and tip. Grow attached at base to solid objects by means of gelatinous holdfast. Reproduction by transverse fission of the segments, and by rod-shaped socalled conidia, prohably arising by the spical segments becoming free. Temporarily, the conidia show creeping motility, settle on solid objects, and grow out into new filaments.

The type species is Thiothrix miea (Rabenhorst) Winogradsky.

The following key to the species of the genus Thiothriz is based upon the diameter

<sup>\*</sup> Completely revised by Prof. C B. Van Niel, Hopkins Marine Station, Pacific Grove, California, January, 1914.

of the filaments and their habitat, the only criteria used by previous authors for the differentiation of the seven published species. The validity of these distinguishing characteristics is, however, doubtful because their constancy has not been sufficiently established; so far the morphology of the Thiothrix species has not been studied in pure cultures.

#### Key to the species of genus Thlothrix.

- I Found in fresh water environments.
  - A Diameter of filaments about 2 (1.4 to 30) microns. 1 Thiothrix nirea.
  - B. Diameter of filaments about 1 micron. 2. Thiothrix tenuis.
  - C Diameter of filaments less than 0.5 micron.
- II l'ound in marine environments
- 3. Thiothrix tenuissima
- - A Diameter of filaments averages about 20 microns (actual range 15 to 30 ml. erons)
    - 4. Thiothrix toukis
  - B Diameter of filaments about 4 (4 4 to 6 6) microns, Segments about 25 microns lone 5 Thiothrix longiarticulata.
  - C. Diameter of filaments about 3 (1.8 to 5) microns. Segments about 1 micron iong.
    - 6. Thiothrex annulata
  - D Diameter of filaments about 1 (0 8 to 1.3) micron.
    - 7. Thiothy I maring.

1 Thiothrix nives (Rabenhorst) Winoreadsky (Beggiatog nirea Rabenhorst, Plora curopaca algarum, 2, 1865, 91; Leptotrichia niica De Toni and Trevisan. in Saccardo, Sylloge Puncorum, 8, 1889. 931. Sumphyothers nicea Wartman and Schenk, Schweiz. Kryptogamenflora; Winogradsky, Beitr. z. Morph. u. Physiol d Bact., I, Schwefelbacterien, 1888, 39 ) From Latin stretts, snowy,

Lilaments with a thin sheath, diameter 20 to 30 interest at base, 1.7 microus in the middle, 1.4 to 1.5 microns at tip As long as the filaments contain sulfur globules, segmentation is invisible; length of segments 4 to 15 microus, the toneerones usually near apex, the shorter ones near base.

Mottle segments (so-called conidia) mostly single, 8 to 15 microns long, sometimes in short filaments of 2 to 4 cells and up to 40 microns long. These segments may settle and develop near the

base of the mother filament or on a filament steelf, forming verticiliate structures. These have been described as Thiotheix nirea var verticillata Mivashi (Jour. Coll. Sci. Imp. Univ. Tokyo, 10. 1897, 155).

Habitat: Presh water environments where hydrogen sulfide is present (sulfur springs, stagment pools, on submerged decaying vegetation, etc.).

2. Thiothrix tenuis Winogralsky. (Regnator albr var. unistriales lingler. Ub die Pilz-Vegetation des weisen oder todten Grundes in der Kieler Bucht, 1883. 4. Winogradsky, Brite z Morob, u. Physiol. d Bret., I, Schwefelbreterien, 1888, 43) From Latin tenuis, alender,

l'damente about 10 micron in diam. eter, of nearly uniform thickness. Often in dense, felted masses. Segments 4 to 5 microns long.

Habitat: Fresh water environments

where hydrogen sulfide occurs. According to Bavendamnı (Die farblosen u. roten Schwefelbakt., Pflanzenforschung, Heft 2, 1924, 107) also found in sea water.

 Thiothrix tenuissima Winogradsky. (Beitr. z. Morph. u. Physiol. d. Bact., 18. Schwefelbacterien, 1883. 40; Thiothrix minutissima Uphof, Arch. f. Hydrobiol., 18, 1927, 77.) From Latin tenuis, diminutive, very slender.

Filaments less than 0.5 micron in diameter, usually in dense masses.

Habitat: Fresh water environments where hydrogen sulfide occurs.

4. Thiothrix voukil Klas. (Arch. f. Protistenk., 88, 1936, 123.) Named for Vouk, a Russian scientist.

Filaments 15 to 30, most frequently 17 microns in diameter, of rather uniform thickness. Segments wishle uithout special treatment. Segments generally somewhat longer than wide, rarely square, occasionally barrel-shaped. Length of segments 15 to 30, mostly 19 to 23 microns. Motile segments not yet observed

Apart from the lack of motility, this species closely resembles the motile Beggiatoa mirabilis.

Source Found in effluent of sulfur springs at seashore near Split, Jugoalavia. So far reported only once.

Habitat Marine environments containing hydrogen sulfide

5 Thiothrix longiarticulata Klas (Arch f. Protistenk, 88, 1936, 126) From Latin longus, long and articulatus, nomted.

Filaments 3 3 to 6 6, most frequently 4 2 microns in diameter, of uniform thickness Occur in dense, felted masses. Segments long, measuring 19 to 33, mostly 26 microns in length. Sulfur droplets usually absent in the proximity of cross-walls. Motile segments not yet reported.

Source: Found in effluent of sulfur springs at seashore near Split, Jugoslavia. So far reported only once.

Habitat: Marine environments containing hydrogen sulfide.

 Thiothrix annulata Molisch. (Cent
 Bakt., II Abt., 33, 1912, 53.) From Latin annulatus, ringed.

Filaments 3 to 4, occasionally up to 5 microns in diameter, thinner at base (2 microns) and at tip (1.8 microns). Segments only about 1 micron in length. Often found with narrow bands which are free of sulfur, thus giving a ringed appearance to the filaments. Old filaments may show spacial thickening and distortion, but this is not characteristic for the species.

Habitat: Marine environments containing hydrogen sulfide; frequently on decaying algae.

7. Thiothrix marina Molisch. (Ceat. f. Bakt., II Abt., 55, 1912, 53) From Latin marinus, pertaining to the sea.

Latin marinus, pertaining to the sea-Filaments about 1 (0 8 to 1.3) micron in diameter, of rather uniform thickness. Usually in felted masses

Resembles Thiothriz trauis Since the latter has been reported from marine environments (Bavendamm, Die farblosen u. roten Schwefelbakterica, Pflanzenforschung, Heft 2, 1973, 1971, Phiothriz marina may not be an independent species, but identical with Thiothriz tenuss

Habitat: Marine (?) environments containing hydrogen sulfide; frequently on decaying algae.

# Genus II. Beggiaton Trevisan.

(Prospetto della Flora Euganes, 1842, 56.) Named for the Vicenza physician, F S. Beggiato.

Filamentous, motile, segmented organisms, occurring singly or in white to creamy felted messes in which the separate filaments retain their individuality. Not at-

tached. Existence of a sheath not definitely established. Movements of the flaments dependent upon a solid substratum over which they slide in the aame manner as species of Oscillatoria. Sliding movements often accompanied by rotation of filaments around long axis. Reproduction by transverse firsion of segments; the filaments may also break up into smaller units, each continuing a supratic existence. The latter mode of multiplication corresponds to that by means of the so-called mottle confide no regements in Thathru.

The type species is Beggiatoa alba (Vaucher) Trevisan.

In this genus, also, the species so far described are differentiated on the basis of dimensions. The range of sizes for septrate species appears, it most cases, quite arbitrary, especially in view of the existence of practically all intermediate stages. Since the smaller forms have been found both in fresh water and marine environments (Bavendamm, Die farblosen u roten Schwefelbakteren, Pflunzenforschung, Heft 2, 1921, 193), the previously described Begpiaton marina has been omitted as a septrate species. Pure culture studies may establish more statisfactory methods of differentiation and a better understanding of speciation.

#### Key to the species of genus Begglatoa.

- 1 Diameter of filaments greater than 25 nicrous,
  - 1 Beggiatoa gigantea
- II Diameter of filaments less than 25 microns
  - A. Diameter of filaments greater than 15 microns

    2. Begginten merabilis
  - 2. Beggiatoa mirabilii
    B Diameter of filaments less than 15 microns.
  - 1 Diameter of filaments greater than 5 microns
    - 3 Beggiatoa aracknondea
    - 2. Diameter of filaments less than 5 microns.
      - a Diameter of filaments greater than 2.5 microns
        4 Beggiatos alba,
        as Diameter of filaments less than 2.5 microns.
        - as Diameter of filaments less than 2.5 microns, h. Diameter of filaments greater than 1 micron
          - 5 Beggiatoa leptomiliformis
          - bb Dismeter of filaments less than I micron.
            - 6 Beggiatoa minima

1 Beggiatoa gigantea Klas. (Arch f Mikrolnoi, 8, 1937, 318, includes the arge forms of Beggiatoa mirabilis Cohu, Biedwigia, 4, 1865, 81) From Greek agas, ennt

Filaments 20 4 to 55, average 35 to 40 microus in diameter. Kivs, in his dira noses, gives 20 4 to 42 9 microus as simensions. This would exclude the furgest forms of Beggiaton merchies described by Himse (Ber d. deut. but Ges. 19, 1001, 309). Since the proposal of a separate species for such organisms appears at present injustified, the maximum diameter Last are been increased. Eds.

ments clearly segmented, length of segments 5 to 13, average 85 microns. Terminal cells rounded or tapering.

When the filaments are in healthy combition they are of uniform width; lunging of the sides indicates unfavorable conditions

Habitat Apparently restricted to marine environments containing hydrogen sulfide. Frequent on decaying marine alone.

2 Beggistoa mirabilis Cohn enend Idas (Colm, Hedwigia, 4, 1865, 81; Klas, Arch. f. Mikrobiol., 8, 1937, 318.) From Latin mirabilis, wonderful.

Filaments 15 to 21.5, average 17 microns in diameter. The so-defined species does not overlap with Begietae gigantes according to Klas (loc. cit.). Segmentation usually observable without special treatment; segments 5 to 13, average 5.5 microns long. Terminal cells rounded or tapering, sometimes bent.

When the filaments are in healthy condition they are of uniform width; an unfavorable environment induces bulging of the sides.

Habitat: Apparently restricted to marine environments containing hydrogen sulfide. Common on decaying marine algae.

Uphof (Arch. f. Hydrobiol., 18, 1927, 63) has created a species, Begglados maxima, which on account of its diameter (10 to 20 microns) falls partly within the range of Begglados mirabilis, partly within Begglados arachnoides. Since it was found in a fresh water environment, the habitat of Begglados mirabilis may not be restricted to marine media.

arachnoldea (Agardb) 3 Begglatoa Rabenhorst, (Oscillatoria arachnoidea Agardh, Regensburger Flora, 1827, 634; Rabenhorst, Flora europaea algarum, 1865, 91. Beggiatoa pellucida Cohn, Hedwigia, 4, 1865, 82; ? Oscillatoria beggiatordes Arzichonsky, Bull Jard. Imp. Bot .. St Pétersb , £, 1902, 38, 47; includes the larger members of Beggiaton major. Winogradsky, Beitr. z. Morph. u. Physiol, d Bact , I, Schwefelbacterien, 1833, 25: and the smaller ones of Beggiaton maxima Uphof, Arch f. Hydrobiol., 18, 1927, 80.) From Greek, resembling a cobweb.

Filaments 5 to 14 microns in diameter. Segmentation generally observable only after special staining or removal of suffur globules; segments 5 to 7 microns in length. Terminal cells rounded, often tapering. Filaments of uniform width.

Habitat: Both fresh water and marine environments containing hydrogen sulfide.

4. Begglatoa alba (Vaucher) Trevisan. (Oscillatoria alba Vaucher, Histoire des Conferres d'eau douce, 1803, 193; Beggiatoa punctata Trevisan, Prospetto della Flora Euganea, 1842, 56; Beggiatoa alba var. marina Cohn, Hedwigia, 4, 1865, 83; Beggiatoa marina Molisch, Cent. f. Bakt., 11 Abt., 25, 1912, 55; in part, Beggiatoa major Winogradsky, Beitr. z. Morph. u. Physiol. d. Bzet., I, Schwefelbacterien, 1888, 25.) From Latin of Drs. white.

This is the type species of the genus. Filaments 2.5 to 5, most commonly 3 nuicons in diameter, of even width. Segmentation difficult to detect in filaments containing many sulfur globules; segments 3 to 9 microns long, shortly after division practically square. Terminal cells rounded.

Habitat: Both fresh water and manne environments containing hydrogen sulfide.

Distribution: Ubiquitous, and probably the most common of the filamentous sulfur bacteria.

5. Begglatoa leptomitiformis (Meneghini) Trevisan. (Oscillatoria leptomitiformis Meneghini, Delle Alghe vicenti nelle terme Eugance, 1814, 122; Trevisan, Prospetto della Flora Eugance, 1812, 55; Beggiaton media Winogradsky, Beitr. Z. Morph. v Physiol. d. Bact., I, Schwefelbacterien, 188S, 25.) From Greek leptos, small and mutos, thread and Latin forma, shape.

Filaments 1 to 2.5 microns in diameter, of uniform width. Segmentation only observable after removal of sulfur globules; segments 4 to 8 microns in length. Terminal cells usually rounded.

Habitat. Fresh water and marine environments containing hydrogen sulfide. 6. Beggiatoa minima Winogradsky. (Winogradsky, Beitr. z. Morph. u. Physiol. d. Bacterien, I. Schwefelbacterien, 1888, 28, Beggiatoa minor Uphof, Arch. f. 1ly drobiol., 18, 1247, 79; not Beggiatoa minime Warming, Om Nogle ved Danmarks Kysterlevende Bakterier, 1876, 52, which from the description is

not a Beggiatoa.) From Latin minimus, least.

Filaments less than I micron in diameter, of uniform width. Normally appears unsegmented; length of segments about I micron.

Habitat. Fresh water and marine environments containing hydrogen sulfide.

#### Genus III. Thiospirillopsis Uphof.

(Arch. f. Hydrobiol., 18, 1927, 81) From Greek theion, sulfur M L. spirillum, spirillum and Greek opsis, appearance.

Filamentous, colorless sulfur bacteria, segmented, and spirally wound. Exhibit creeping molility, combined with rotation, so that the filaments move forward with a carkscren-like motion. The tips produce oscillating movements. Resembles Spirulina among the Oscillatoriaccae.

The type species is Thiospirillopsis floridana Uphof.

1 Thiospirillopsis floridana Uphof. (Arch f llydrobiol., 18, 1927, 83) Named from Tlorida, the place where it was first found.

Filaments 2 to 3 microns in diameter. Segmentation difficult to observe without special precautions; segments about 3 to 5 nicrons long. The spiral windings are regular

Source Found in the sulfur spring

water at Welium Springs and Palm Springs, Horida. A very similar organism has been observed at Pacific Greve, California, In a marne aquarum where hydrogen sulfide had been generated by sulfate reduction. The genus

ated by sulfate reduction. The genus Theopirulopsis may, therefore, be more wide-spread than is generally believed. Habitat Probably widely distributed

in water containing sulfur.

### Genus IV. Thioploca Lauterborn

(Ber d.deut botan. Ges ,25,1907,238) Name derived from Greek theion, sulfur, and plota, braid

Filaments of Beggatos-like appearance, but occurring in parallel or braided bundles, enclosed by a common wide sline-sleath. The latter infraquently incrusted on the outside with detritus. Within the sheath the individual filaments are multiin the manner of Beggatos; the filaments are segmented, the terminal segments often tapering.

Resembles closely the genera Hydrocoleus and Microcoleus among the Oscillatoriaceae.

It is doubtful whether the members of the genus Thoploca are true colorless sulfur betters, most investigators of these forms have reported a greenish-blue coloration of the filaments. Only the regular occurrance of sulfur droplets in filaments taken from their natural brints at samps the organisms as sulfur betterns. In view of the close relationship of the Begguatoaccae to the blue-green Oscillatoriaccae, this is, however, a minor issue.

Four species have been described to date. Three correspond, with respect to the individual fluencia, to Regnatou arechnoidea, Regnatou alba, and Regnatou leptoniforms respectively, the fourth appears to be a combination of the first and third.

spēcies of Beggiatoa in a common sheath. This occurrence of two distinct species of Beggiatoa in a common sheath makes the genus a doubtful taxonomic entity. The type species is Thiomloca schmidte Lauterhorn.

### Key to the species of genus Thioploca.

- I. Filaments in a common sheath of fairly uniform diameter.
  - A. Diameter of individual filaments 5 to 9 microns.
  - 1. Thioploca schmidlei.
  - B. Diameter of individual filaments 2 to 5 microns.

    2. Thioplaca ingrica.
  - C. Diameter of individual filaments 1 to 2 microns.
- 3. Thioploca minima.
- Filaments in common sheath of greatly different diameter.
   Thioploca mixta.

 Thioploca schmidlei Lauterborn. (Ber. d. deut. bot. Ges., 25, 1907, 238.)
 Named for Mr. Schmidle

Individual filaments in a common sheath 5 to 9 microns in diameter, clearly segmented Segments 5 to 8 microns in length. Mucilaginous sheath 50 to 160 microns in diameter. Number of filaments embedded in one sheath variable

ments embedded in one sheath variable Source · Various localities in Central Europe.

Habitat. So far reported only in fresh water mud, containing hydrogen sulfide and calcium carbonate.

2 Thiopioca Ingrica Wislouch (Ber d. deut bot. Ges, 30, 1912, 470) From Ingria, an ancient district of Leningrad.

Individual filaments in common sheath 2 to 45 micross in diameter, clearly segments 1.5 to 8 microns in length. Mucilaginous sheath up to 80 microns in diameter. Number of filaments in one sheath variable.

Source, Various localities in Central Europe.

Habitat Found in fresh water and marine mud containing hydrogen sulfide

 Thioploca minima Koppe. (Arch. f. Hydrobiol, 14, 1923, 630) From Latin minimus, least

Individual filaments in a common sheath 08 to 15 microns in diameter, segmentation generally observable only after removal of sulfur droplets. Segments 1 to 2 microns long. Muellaginous sheath up to 30 microns in diameter. Number of filaments in one sheath variable.

Source: Various localities in Central Europe.

Habitat: Fresh water and marine mud containing hydrogen sulfide.

 Thioploca mixta Koppe. (Arch. f. Hydrobiol., 14, 1923, 630.) From Latin mixtus, mixed.

Individual filaments in a common sheath of two clearly different sizes, comprizing both filaments of 6 to 8 microns, and filaments of about 1 micron in diameter. The former are clearly segmented, with segments of 5 to 8 microns in length. In the latter segmentation is visible after removal of sulfur droplets; segments 1 to 2 microns long. Mucilaginous sheath usually about 50 microns thick. Number of filaments in one sheath variable.

Source Reported so far only from Lake Constanta.

Habitat: Fresh water mud containing hydrogen sulfide.

Appendix: In addition to the above genera and species, a number of insufficiently characterized, filamentous sulfur bacteria which may be related to the Beggiatoaceae have been described under

Conidiothrix sulphurea Petersen (Dansk Boton, Arkiv, 1, 1921, 1)

l'ilamentous, nonmotile organisms, of uniform width, between 0.5 and 1 micron in diameter, covered on the outside Segmentation not rewith sulfur ported. The cutstanding characteristic of the genus Consdigthriz is the supposed multiplication of the filaments by means of conidia which arise by budding on the filament. Apart from this reported occurrence of a budding process, the description is similar to that of Leptothrix sulphurea and of Thiothrix tenuis and Thinthrix tenuissima. Since consecutive observations on growing organisms are lacking, it seems advisable to consider Conidiothriz sulphurea as probably identical with Thiothrix tenuis or Thiothrix tenuissima

Leptothriz sulphurca Mijochi (Jour Coll Sci, Imp. Univ. Tokyo, Japan, 10, 1807, 151)

Filamentous, non-motile organisms, of uniform width, not exceeding 0.7 micron in listancter. The filaments are covered on the outside with a powlery deposit of elementary sulfur. Segmentation observable only after special statung; length of regreents not published.

I ound by Miyoshi in sulfur springs in Japan. Although not reported as containing sulfur globules unide the fitsments, the description would closely fit Theolitz (mains or Theolitz tenus and Winogradsky. The latter have been observed in masses covered on the outside with clementary sulfur. Therefore, it seems likely that Leptothriz sulfphurca is a synonym for Theolitz tenus or Theolitz tenussing.

Thionema raginalum Kulknitz (Ber d deut but Ges. 56, 1939, 11.) The type species of the genus

Described as a filamentous, colories saffur bacterium, non-motile, attached in the manner of Thiothriz. Tilaments 15 to 2 microns in diameter, segmented. Segments 2 to 5 nicrous long Reproduction, as in the case of Thiothriz, by means of detached secrents.

While this part of the description fits that of Thather mrea, the new generic name was proposed on the basis of the occurrence of a distinct sheath, frequently impreparted with iron compounds Sance Winogradsky mentions the occurrence of a sheath also in Thothers mirea, it seems desirable to consider Thonema togunatum, at least for the time being, as a probable synonym of Thather end with the contraction of the state of the time being, as a probable synonym of

Source Found on waterplants in the Tettow-Canal near Berlin, the water containing hydrogen sulfide and iron salts.

Thiosiphon adriaticum Klas, (Sitzungsber, Akad. d. Wissensch, Wien, Mathem.-naturw, Kl., 1, 145, 1936, 200)

Described as a filamentous suffur barterium, non-motile, but without segmentation, hence tubular and nucellular. Multiplication by means of condita arising from restriction of the apical put of the cell Length of filament about 1 to 15 mm, with 17 to 33 microna, wually tapering towards apex. Condid 13 to 39 microsa by 30 to 50 microns.

The description is at variance with the appearance of the organism in the published photomicrograph in so far as the sare of the coundry is voncerned. From the photomicrograph this injurant to be about 30 by 200 microns. The chitrappearance is atrongly reminiscent of that of Regination mirrolitis (Regination gigostaria) in certain culture. The floort confets, described in the text, strikingly resemble species of Advancation, Consecutive observations on growing cultures of Principles of an appear to

have been made. Since (a) the internal structure of the large Beggiatoaceae is easily damaged, (b) the segmentation in living individuals is difficult to observe when the filaments are filled with sulfur, (c) the presence of Achromatium in the

locality from which Thiosiphon was col lected is almost certain, and (d) the developmental cycle is merely a reconstruc tion of simultaneously observed clements, considerable doubt as to the validity of the genus appears justified,

\* Appendix I: The group of large, unicellular, colorless sulfur bacteria is placed here as a single family, Achromatiaceae Massart as in previous editions of the MANUAL. It includes organisms which are similar in physiology to the Beggiatoaceae,

Massart (Rec. Inst. Bot. Univ. Bruxelles, 5, 1902, 251) proposed the family Achromatiaccae for the bacteria described by Schewiakoff (Uber einen neuen bacterienahn. lichen Organismus des Süsswassers, Habilitationsschrift, Heidelberg, 1893) as Achromalium oxaliferum. The family diagnosis was modified by Nadson (Jour, Microbiol., St. Pétersb., 1, 1914, 72) and by Nadson and Wislouch (Bull. Princip. Jard. Bot. Republ. Russe, 22, 1923, 33) to include the genera Thiophysa and Thiosphaerella.

In this form, the family represents a homogeneous group of organisms, all characterized by a pronounced similarity in cell-shape, structure, method of reproduction and motility. They exhibit very slow, jerky and rotating movements, but are devoid of flagella or other visible organs of locomotion. They closely resemble the blue-green algae of the genus Synechococcus, even in size.

By including the genus Thiospira in the family Achromatiaceae, Buchanan (Jour. Bact., S. 1918, 462) modified the diagnosis to read:

Unicellular, large, motile (by means of fiagella?). Cells containing granules of sulfur (or ig one form possibly exalate) but no bacteriopurpurin.

Thus was proposed a family in which the spiral sulfur bacteria, indubitably related to species of Spirillum among the Eubacteriales, were linked with the tayonomically obscure species included in Achromatium and Thiophysa. Four genera, Achromatium, Thiophysa, Thiospira and Hillhousia were recognized.

Rawandamm (Die farblosen und roten Schwefelbakterien, Pflanzenforschung,

Cells free, motile. As he realized that Hillhouse enough be regarded as a so of Achromatium and added the genus Thiovulum Hinze (Ber. d. deut. bot. Ges., 31, 1913, 195), four genera were again included in the family. Thiosphaerella was added as an appendix to Thiophysa.

Thiorulum is morphologically similar to Achromatium, Thiophysa, and Thiosphacrella with respect to cell size and structure, but differs conspicuously in being actively and rapidly motile. The manner of locomotion suggests the presence of polarly inserted flagella. However, these have never been demonstrated con-

vincingly.

While it is conceivable that a relationship exists between Thiorulum and the organisms of the Achromatium type, the combination of the representatives into one family should be regarded as tentative and open to question. There certainly is no justification at present for including the sulfur spirilla in this family. These are placed in this edition of the MANUAL in Spirillege among the Eubacteriales.

<sup>\*</sup> Completely revised by Prof. C. B. Van Niel, Hopkins Marine Station, Pacific Grove, California, January, 1944.

#### FAMILY A. ACHROMATIACEAE MASSART.

(Rec. Inst Bot. Univ Bruxelles, 5, 1902, 251.)

Cells large, spherical to ovoid in shape, sometimes rod-shaped, may contain globules of sulfur and for calcium carbonate crystals. Do not possess photosynthetic pigments. Tresh water and marine forms,

A satisfactory differentiation of the cenera Achromotium, Thiophusa, and Thiosphaerella is at present well-nigh impossible. They have here been combined into a

single genus, Achromatium.

Achromatium mobile Lauterborn (Verhandl Natur-histor .- Mediz, Vereins Heidelberg, N. F., 13, 1915, 413) is fundamentally different from the other members of the genus. It powesses a clearly visible polar flagellum, suggesting its close affinity with the Pseudomonadaceoe among the Eubacteriales. Whether it is a true sulfur bacterium has not been established with certainty; this appears very doubtful in the case of the two similar forms described as Pseudomonas bipunctata and Pseudomonas hyalina by Gickling (Cent f Bakt, II Abt, 50, 1920, 425, 426). Utermohl and Koppe (Verhand). Intern Ver f theoret. u. angew. Limnologie, 1913, 86 and Archiv [ Hydrobiol., Suppl Bd 5, 1925, 231) have proposed the generic name Macromonos for this group. This has been adopted here.

All of the above mentioned organisms have so far been studied exclusively as found in their natural habitats. Pure culture studies are greatly needed. These may show that the neculiar calcium carbonate inclusions (not calcium ovalute as thought by Schewinkoff, nor calcium throsulfate as believed by Hannevart) in Achromattum ozaliferum and in Macromonas bipunctata occur only under special environmental conditions.

#### Key to the ocnera of family Achromatiacese.

- I. Large, evold to spherical organisms, normally containing sulfur globules when found in the presence of hadrogen sulfide,
  - A Non-mottle, or slowly, jerkely sliding across the substrate. Genus I. Achromatium, p. 997.

B Actively motile, independent of the substrate, Genus II. Thiorulum, p. 999

11 Red theped and curved erganisms, motile by means of polar flagella.

A Bean-sheped to short red-shaped organisms which may contain small sulfur

globules, but are chiefly characterized by large, round spherules of calcium carbonate as cell inclusions. The polar flagellum is often visible in the larger forms without special staming

Genus III Macromonas, p. 1000.

#### Genus I Achtomatium Schewinkoff.

(Schewinkoff, Ub. einen neuen breterienshinlichen Organismus des Süsswassers, Habilitatic verche., Heidelberg, 1893, Modderula Frenzel, Biel Centralbi , 17, 1897. 101. Hilliousia West and Griffiths, Proc. Roy Sec. B, 81, 1909, 389). From Greek a, without and chroma, color

Throphysa Himze (Ber. d deut bot Ges , 21, 1903, 309) and Throsphacrella Nadson (Jour Microbiel , St. 1 (tersb , t, 1914, 72) are also included in the group as defined bere

Unicellular erganisms with large cells, shortly cylindrical with hemispherical extremities, also ellipseided to apteried Cells divide by a constriction in the middle. Movements, if any, are of a slow, rolling, jerky type and are dependent upon the presence of a substrate. No special organs of locomotion are known. In their natural habitat, the cells contain sulfur droplets and sometimes additional inclusions, such as large spherules of calcium exhomate.

The type species is Ackromatium ozaliferum Schewinkoff,

It is not easy as yet to determine whether several species should be recognized in this genus. There appears to be some justification for differentiating between the forms which contain the characteristic and conspicuous calcium carbonate inclusions and forms in which these large spherules are lacking. The former have been reported mostly from fresh or brackish water environments, while the characteristic habitat of the latter seems to be marine. It is, of course, probable that the internal deposition of calcium carbonate depends upon the composition of the environment, so that the distinction may prove orbitary and non-specific.

Achromatium cells of widely different sizes have been described. Schewiakoff (bb. einen neuen bacterienahnliehen Organismus des Süsswassers, Habilitationsschrift, Heidelberg, 1893) mentions a variation of 15 to 43 microns in length, and 9 to 22 microns in width for Achromotium oxaliferum. Larger cells have been observed by Warming (Videnskab. Meddel. naturhistor. Foren., Kjöbenhavn, 1875, No. 20-23, 360, size to 85 microns), ond by Virieux (Ann. Sci. Natur., Sci. 9, 18, 1913, 265; size

to 95 microns in length).

Nadson (Bull Jard. Imp. Botan., St. Pétersb., 13, 1913, 105; Jour. Microb., St. Pétersh., 1, 1914, 52) proposed the name Achromotum gigas for the larger organisms. also West ond Griffiths (Ann. Bot., 27, 1913, 83) created two species, Hillboura mirabits, with sizes of 42 to 86 microns long by 20 to 33 microns wide, and Hillboura palustras, measuring on the average 14 by 25 microns, for the same group of sulfur hacteria.

However, Bersa (Sitzungsber, Akod. Wiss., Wien, Mathem.-insturw. Kl., I, 189, 1920, 233) observed so many intermediate sizes that he recognized only a single species. Nadson and Wislouch (Bull. Prine. Jard. Botan., Républ. Russe, £2, 1923, Supnil. 1, 33) orrayed at the same conclusion, and this view is occepted here.

The marine Achromatium types which do not contain calcium carbonate crystals, also have been segregated into species on the basis of their size. Here again, there does not seem to be any valid reason for maintaining several species as there is a

continuous series of intermediate forms.

Thus, the organisms previously described as Achromatium oxaliferum, Achromatium gigas, Hillhousia mirabilis and Hillhousia palustris are provisionally treated here as one species, while the marine counterpart, Thiophysa volutans, is combined with Thiophysa macrophysa and Thiosphaceella amylifera, all three being regarded as Achromatium volutans

Key to the species of genus Achromatium.

muds.

Į. .

1. Achromatium ozaliferum.

Organisms naturally occurring without such calcium carbonate inclusions.
 Found in marine mud.

2. Achromatium volutans.

 Achromatium oraliferum Schewiakoff. (Schewiakoff, Üb. einen neuen hacterrenahnlichen Organismus des Süsswassers, Habilitationschrift, Heidelberg, 1803; Modderula hartungi Frenzef, Biol. Centralbl., 17, 1907, 501; Hillhowsto mrabbits West and Griffiths, Proc Roy. Soc., B. 81, 1909, 380; Hillhowsto patustris West and Griffiths, Ann Bot. 27, 1913, 83, Achromatium gipas Nadson, Bull. Jard. Imp. Bot., St. Pétersb., 18, 1913, 1909. From Latin oralis, intended to refer to the supposed presence of ovalate cristals and tero, to bear

Unicellular organisms, varying in shape from spherical or owned to shortly cylindrical with hemispherical extremiters. Division by constriction in the middle. Cells vary in size from spheres of about 7 microns or even less in diameter to giant forms 100 microns long by 35 microns wide. The extremes are connected by a continuous series of inter-

mediate sizes

Organisms may show motility of a jerky and rotating kind, always very slow, and dependent upon a substrate Typical organs of locomotion absent

Normally contain small sulfur globules, accompanied by much larger calcium carbonate crystals, the latter in the form of large highly refractile spherules. Under favorable environmental conditions these may disappear before the sulfur globules. Cells with calcium carbonate inclusions have a very high specific gravity. They are, therefore, found only in the bottom of pools, streams, etc., usually in the mud.

Strictly microserophilic, and apparently require hydrogen sulfide.

Habitat: Fresh water and brackish mud containing bydrogen sulfide and calcium salts According to Nadson and Wislouch (Bull princip Jard. bot., Républ. Russe, \$2, 1923, Suppl. 1, 33) also in marine mud

2 Achromatium volutans (Ilinze) comb.
nov. (Thiophya volutans Illinze, Ber. d.
deut bot. Ges. 21, 1903, 309; Thiophyas
macrophya Nadson, Bull. Jard. Imp.
Bot, St. Yetersb. 13, 1913, 106 and Jour.
Microb., St. Pétersb., 1, 1914, 51; Thiosphacrella amyliyera Nadson, Bull. Jard.
Imp. Bot., St. Pétersb., 13, 1913, 106 and
Jour. Microb., 5t. Pétersb., 14, 1914, 51.)
From Latin tolutans. vollutal

Unicellular organisms, spherical to ovoid in shape, dividing by constriction in the middle. Size variable, ranging from spheres about 5 microns in diameter to ovoids up to 40 microns in length.

Cells may show motility of a jerky and rotating kind, always very slow, and dependent upon a substrate. Typical organs of locomotion absent.

Normally contain sulfur globules, but lack large internal calcium carbonate demests

Microacrophilic, apparently requiring hydrocen sulfide

Habitat Marine mud containing bydrogen sulfide, decaying seaweeds

### Genus II Thiovulum Henze

(Ber d. deut. bot Ges , \$1, 1913, 195) From Greek theton, sulfur and Latin orum, egg

Unicellular organisms, round to avoid. Cytoplasm often concentrated at one end of the cell, the remaining space being occupied by a large vacuole. Multiplication by construction which, in late stages, merges into fission. Actively mottle; movements accompanied by rapid rotation. Flagilistion and definitely demonstrated, but type of locomotion suggests polar flagilistion. Normally containsulfur globules in the cytoplasm, hence, these are frequently concentrated at one end of the cell.

The type species is Thiorulum majus Hinze.

As in the case of Achromatium, it is difficult to establish distinct species. Those that have been described differ only in size, and the differences appear to be far from constant. For Thiopulum (Monas) milleri (Warming) Lauterborn (Verhand). Naturhist. medizin. Vereins, Heidelberg, N. F., 15, 1915, 414) the diameter is stated by Warming (Videnskah, Meddel, naturhistor, Fortn., Kjöbenhavn, 1875, No. 20-23, 363), Hinze (Ber. d. deut. bot. Ges., 51, 1913, 191) and Lauterborn (loc. cit., 415) respectively to be 5.6 to 15, 12 to 15 and 5 to 13 microns. The ovoid cells of Thiorulum majus are noted as being 11 to 18 microns long and 2 to 17 microns wide, while Thiorulum minus comprises the smaller forms from 9.6 to 11 microns long by 7.2 to 9 microns wide. In view of the regular occurrence of all intermediate sizes it seems best to recognize only a single species at present.

1. Thlovulum majus Hinze. (Ilinze, Ber. d. deut., bot. Ges., 31, 1913, 195; in-cluding Thiorulum minus Hinze, idem.; Monas mulleri Warming, Videnakab. Meddel. naturhistor. Foren., Kjöbenhavn, 1875, No. 20-23, 393; Achromatium mulleri Niigula, Syst. d. Bukt. 2, 1900, 1933, Thiovulum mulleri Lauterborn, Verhandl. Naturhist.-medizin. Vereina, Hekdelberg, N.F., 13, 1915, 414.) From Lattin major. large

Unicellular organisms, spherical to ovoid Cytoplasm often concentrated at one end of the cell, the remainder being occupied by a vacuole. Multiplication by constriction which, in late stages, merges into fassion. Size of cells, 5 to 20 microns in diameter.

The most characteristic feature is its motility; it is the only one of the spherical to avoid, colorless sulfur bacteria capable of rapid movement. Flagellation has not been definitively demonstrated, but the type of locomotion suggests the presence of polar flagella.

Normally contains sulfur droplets in cytoplasm, frequently concentrated at one end of cell.

Microaerophilic; apparently requires hydrogen sulfide.

Habitat: In sulfide-containing water, usually accumulating near the surface. Often in cultures of decaying algae Both in fresh water and marine environments.

### Genus III. Macromonas Utermohl and Koppe.

(Verhandl, Intern Ver f. Theoret, u. angew. Limnologie, 1923, 86.) From Latin macro, large and monas, a unit or cell

Colorless, cylindrical to bean-shaped bacteria, actively motile by means of a single polar flagellum. Multiplication by constriction (fission). Chiefly characterized by the occurrence of calcium carbonate inclusions in the form of large spherules, In their natural habitat they may also contain small sultar globules.

The type species is Macromonas mobils (Lauterborn) Utermohl and Koppe.

Two species have primarily been distinguished on the basis of cell size. Whether
this is sufficiently constant to serve as a specific character has not been definitely
established. From studies still limited in scope and extent on the organisms in their
natural habitat, it appears at present that the two species should be maintained, at
least provisionally. It is possible, however, that further observations, especially
with cultures under different environmental conditions, will show the occurrence of
intermediate types and of a greater range of variation in size of pure cultures than

what has previously been reported.

### Key to the species of genus Macromonas.

- I. Cells measuring 12 microns or more in length and 8 microns or more in width.
  1. Macromonas mobilis
- If. Cells measuring less than 12 microns in length and 5 microns or less in width.

  2. Macromonas bipunciala.

 Macromonas mobilis (Lauterborn) Utermöll and Koppe. (Achromotum) mobi e Lauterborn, Verhandl. Naturhist. Medizin Vereins, Reidelberg, N F., 15, 1915, 413; Merospira vecillans Geklhorn, Cent. i Bakt, II Abt., 85, 1920, 422; Utermöll and Koppe, Verbandi Intern. Ver f. theoret u angew Lamnologie, 1923, 86 and Uterröli and Koppe, Arch. I. Ilydrobiol., Suppl Bd. 8, 1923, 234)

Coloriess sulfur bacteria, always occurring singly, slightly curved, elongated ellipsoids or cylinders with broad hemispherical ends. Length varies from f2 to 30 microns, width from 8 to 14 microns, most common size 20 by 9 microns. Multriplication by constriction in the muldle

Cells actively motile by means of a single polar fiscellum, distinctly visible without special staining. It is 20 to 40 mlerons long, and, with respect to the direction of motilon, always posteriorly placed. Ratio of movement somewhat sluggish, about 800 mlerons per manute, probably on account of high specific gravity of cells.

Normally contain small sulfur droplets and, in addition, large, roughly spherical inclusions of calcium carbonate. Two to four such crystal masses almost fill a single cell. Under unfavorable conditions the calcium carbonate crystals may disappear before the sulfur cichules.

Microaerophilie; apparently require

fishitat Tresh water environment containing sulfide and calcium ions, in shallow liasing and streams in the upper layers of the mud

2. Macromonas bipunctata (Gickfhorn)

Utermohl and Koppe. (Pseudomonas bipunetata Gickhorn, Cent. f. Bakt., II Abt., 50, 1920, 425; Utermohl and Koppe, Arch. f. Hydrobiol, Suppl. Bd. 5, 1925, 235)

Ceffs colorless, occurring singly, cylindrical with hemispherical ends, after cell division often temporarily pearshaped. Length 8 to 12 microus, width 3 to 5 microus. Multiplication by constriction in the middle.

Actively motile by means of a singlepolar flagellum, about 10 to 18 microns long, and always posteriorly placed with respect to the direction of movement. Plagellum delicate, not visible without staining. Rate of movement sluggish, about 600 microns per minute. Probably tills slow motion is on account of the bigh specific gravity of the cells

Normally contain calcium carbonate crystals as inclusions. These are in the form of large spherules, one or two of which nearly fill the individual cells, Sultry globules have not been demonstrated with certainty as yet.

Microaerophilic, but it is uncertain whether hydrogen sulfide is required. Source: I rom stems, leaves, etc. of fresh water plants in ponds near Graz, Austria

Habitat: Presh water environments containing calcium ions, but it has been found in sulfide-containing as well as in sulfide-free water in shallow basins and streams in upper layers of the mud

Note. Another species in this genus is Macromonal hydran (Gicklinna) Utermall and Koppe. (Pseudomonas hydran Gickhorn, Cent. f. Bakt., If Abt., 80, 1920, 429, Utermall and Koppe, Arch. Hydrobiol, Suppl., 8, 1925, 225) Smiller to Macromona bipunctata.

# APPENDIX TO ORDER CHLAMYDOBACTERIALES

A recently recognized order of filamentous bacteria includes organisms similar in many ways to those included in Chlamydobacteriales.

### ORDER CARYOPHANALES PESHKOFF.\*

(Jour. Gen. Biol., (Russian), 1, 1940, 611, 616.)

Filamentous or bacillary bacteria of variable size characterized either by the praence of a central body or a ring-like nucleus which frequently takes the form of a disk. These bodies are clearly visible in the living cells. The nuclear clements give a clearcut Feulgen reaction. The filaments may be enclosed in a sheath. Coloriess The individuals consist of cylindrical cells enclosed in a continuous sheath or they are tube-like coenceytic organisms containing varying numbers of ring or disk-like nuclei separated from each other by alternating protoplasmic segments. These may distitegrate into mononucleate encould cells. Gonidia sometimes formed. Found in water and in the intestines of arthropods and vertebrates.

### FAMILY I. PONTOTHRICACEAE PESHKOFF.

Jour. Gen. Biol. (Russian), 1, 1940, 611, 616.)

" to f to the state of the stat

living forms.

### Genus I. Pontothrix Nadson and Krossilnikow.

(Comp rend. Acad. Sci. de U.R.S.S., A, No. 1, 1932, 243-247.) Characters as for the family.

The type species is Pontothriz longissima (Molish) Nadson and Krassilnikow.

 Pontothrix longissima (Molish) Nadson and Krassilnikow. (Chlamydothrix longissimo Molish, Cent. f. Bakt., II Abt., 53, 1912, 60; Nadson and Krassulnikow, loc cit, 243.) Cells in the fila-

ments, 1.5 to 2.0 by 1.0 to 5.0 microns. Filaments 0.5 cm in length. Cells show a central chromatin body. Found on Zostera marina in the Bay at Schastopol on the Black Sea.

### FAMILY II. ARTHROMITACEAE PESHKOFF.

(Jour. Gen. Biol. (Russian), 1, 1940, 611, 616.)

Filaments probably divided into cells although septa (protoplasmic?) disappear during sporulation. Disk-like nuclei alternate with thin protoplasmic segments (septa). Spores form in the distal ends of filaments. Non-motile. The filaments are attached by a spherical body in groups to the intestinal wail of inserts, crustaceans and tadpoles

## Genus I. Arthromitus Leidy.

(Proc. Acad Nat Ser., Philadelphia, 4, 1849, 227)

Characters as for the family. Although the description is worded somewhat differently, there does not seem to be any essential difference between this and the following genus

The type species is Arthromitus cristatus Leidy

<sup>\*</sup>Arranged by Prof. Michael A. Peshkoff, Institute of Cytology, Acad. of Sci., Moscow, U.S S R., April, 1947

- 1. Arthromitus Cristatus Leidy (Proc Acad. Nat. Sci. Phula., 4, 1849, 222 and Jour. Acad. Nat. Sci. Phula., 4, 1849, 222 and Jour. Acad. Nat. Sci. Phula., 8, 1831, 443.) From the intestine of the milliped (Juliss margunatus) and the termite (Retulutermes floripes). Filaments delicate, straight or infleeted, growing in tuits usually of moderate density, from minute, attached, yellowsh rounded or oval bodies Articuli short, cylindre, uniform, length 275 microns, width 0 6 micron, no trace of interior structure Length of filament 67 to 513 microns, breadth 0 6 micron.
- 2. Arthromitus intestinalis (Valentin)
  Peshhoff. (Hygrocrocis intestinalis Valentin, Report f. Anat u Phys, 1, 1836,
  000; Peshhoff, Jour Gen Biol. (Russian),
  1, 1940, 597.) From the intestine of the
- cockroach (Blatta orientalis). Chatton and Perard (Compt rend. Soe Biol, Pana, 74, 1913, 1160) conclude that this species and Arthromitus cristatus Leidy are of the same genus although they accept the name Hygrococis as having priority However, the latter is invalid as a bacterial genus because it was given earlier as the name of a genus of algae. See Buchanan, General Systematic Bacterology, 1925, 183.
- 3. Arthromitus nitidus Leidy. (Smithsonian Contributions to Knowledge, 6, 1852, 35.) From the intestine of the milliped (Julus marginatus).
- 4 Arthromitus batrachorum Collin. (Arch Zool. Expér et Gén, \$1, 1913, 63) From the alimentary tract of toad tadpoles (Bufo calamila)

### Genus II Coleomitus Duboscq and Grassé

(Coleonema Duboseq and Grassé, Arch Zool Expér. et Gén , 68, 1929, Notes et Revue, 14, not Coleonema Bartl and Wendl , 1924, fam Rutarena, Duboseq and Grassé, Arch Zool Expér et Gén , 70, 1939, N et R , 28)

Long filaments, divided by partitions Bscillary elements in basal region. Ovoid or ellipsoidal spores in other parts of filament originating by transformation from these bacillary elements through sporoblasts

The type species Is Coleomitus prurots Duboseq and Grasse

 Coleomitus pravoit (Duloscq and Grassé) Duboscq and Grassé (Coleonema pruvoit Duboscq and Grassé, Arch Zool. Expér. et Gén., e8, 1927, Notes et Revue, 14, Arch Zool. Evpér. et Gén., 70, 1930, N. et II., 28) In the intestine of a termite (Kalaternes sp.) from the Loyalty Islands. Filaments with hyaline sheath, length variable up to 320 merons, breadth 1.3 merons Baculary elements 3 to 4 merons long, also elements up to 6 microns with a chromatic granule or dise in the middle of the body. Spores ellipsoidal 0.8 to 9 by 1 7 to 2 0 merons, all containing an excentrically placed granule of volution.

#### FAMILY III. OSCILLOSPIRACEAE PESHKOFF.

(Jour. Gen Biol (Russian), 1. 1910, 611, 616 )

Bacillary and filamentous forms Filaments are most probably partitioned to form narrow cells each containing a central chromatin body (disk-like nucleus). These give a clear Feulgen reaction, and are embedded in hydine protoplasm. Spores are formed by a fusion of 2-3 protoplasts of neighboring cells. Actively motile The character of the motion sugcerts the presence of peritrichous flagells. Parasitie in the intestinal tract of vertebrates. Members of the genus Sporocytophaga are not known to produce fruiting bodies as such, but often dense agglomerations of shortened rods or cocci have been noted; these may be interpreted as primitive forms of fruiting bodies.

Physiologically most species show great similarity, preferring substrates rich in

cellulosic or other complex carbohydrate materials.

Most of the known species are saprophytic or coprophilic and may be found on dung, in soil, on rotten wood, straw, leaves, etc. They frequently appear to live in close association with various true bacteria and are probably parasitic on them Many have been cultivated on dung. One species is aquatic and parasitic on an alga, Cladophora sp (Gestler, Arch. I. Prostistenol., 50, 1924, 67). One is parasitic (?) on lichens and some are halophilic marine forms (Stanier, Jour. Bact., 40, 1910, 623). Another species is reported as pathogenic for fish (Ordal and Rucker, Proc. Exper Biol and Med. 55, 1914, 15).

Culture media. The myxobacteria are frequently cultured by transferring to dung. For certain apecies sterilized dung has been reported as less favorable than the unsterilized. Dung decoction agar has often been employed. Among the early investigators, Quebl (Cent. f. Bakt., II, Abt., 16, 1906, 9) secured slow growth of some species on malt extract-gelatin at 18° to 20°C with digestion of the gelatin. Potato-nutrient agar was reported better than dung agar, while no growth occurred on sterilized potato alone. Peptone was considered necessary; glucose had little effect. Pinoy (Comp. rend. Acad. Sci., Paris, 187, 1913, 77) claimed that satisfactory development of Chordromyces creatus depended upon the presence of a species of Microeccus in the medium. Kofler (Sitzber. d. k. Akad. Wiss., Wien, Math. Nat. Klasse, 122 Abt., 1913, 845) successfully used a sucrose-peptone agar to which was added pofassium and magnesium salts.

Recent evidence indicates that the carbon requirements of these organisms are met satisfactorily by the more complex carbohydrates, and frequently by their products of hydrolysis. Mishustin (Microbiology, Moscow, 7, 1933, 427), Indenecki and Sointzeva (Microbiology, Moscow, 6, 1937, 3), Krzemieniewski and Krzemieniewska (Acta Soc Bot. Pol.,  $\delta$ , 1927, 102) and others have reported good growth of several

species of myxobacteria on cellulose.

Beebe (Jour Bact., 49, 1940, 155) claimed several species to be facultative parasited on various true bacteria. Good growth was obtained on suspensions of killed bacterial cells in 1 5 per cent agar. Sniesko, Hitchner and McAllister (Jour. Bact., 4f, 1941, 26) showed the destruction of living bacterial colonies by colonies of myxobacteria.

Temperature range. Most species cultivated in the laboratory show a minimum between 17° and 20°C though some species grow at 10°C. Maximum growth usually occurs at about 35°C and the maximum growth temperature is about 40°C. More

normal fruiting bodies are produced at lower temperatures.

The Krzemieniewskis (Acta Soc Bot. Pol., 5, 1927, 102) report that the fruiting bodies of Meditlangium boletus, Myzococcus verscens, Chandrooccus coralloides, Archangium gephyra and Archangium primgenium var. susrgens first develop, followed by Polyangium fusecum and P fuseum var. selatum At 30°C they appear in about 5 to 7 days, and at 11° to 14°C in 24 to 30 days. Each 10°C rise in at 17° to 20°C in 5 to 12 days, and at 11° to 14°C in 24 to 30 days. Each 10°C rise in the pressure approximately halves the time. Other species are slower in developing.

The vegetative rods. The vegetative cells are long, flexuous rods, often 30 times as long as broad abnormally long at the ends Jahn (1924, loc at ) described spindle-shaped cells. Thaxter (flot. Gaz., 37, 1904, 405) believed that a highly clastic wall was present; other authors have

failed to prove it by plasmolytic agents. Jahn states that tinctorial and chemical methods failed to definitely show the presence of a membrane, but that the elasticity of the cells show this clearly. The cells are flexible, not rigid as are ordinary bacteria. Beebe (Jour. Bact., 41, 1941, 214) reported the presence of a cell membrane in Muzococcus zanihus, often made visible with proper staining procedures. The cells frequently show one or more refractive granules. Thanter also noted nucleus-like granules in the anores of Myzococcus, while Bauer (Arch. f. Protistenk . 5, 1905, 92) reported that during germination of the spores of Myzococcus a refractile granule is found at each end of the cell Badian (Acta Soc Bot Pol., 7, 1930, 55) stated that the cell of Muzococcus virescens lacks a true nucleus, but that there is present a basophilic structure probably nuclear in nature. It is dumb bell-shaped and divides longitudinally in mitosis. In spore formation an autogamy occurs followed by what appears to be a reduction division. All chromatin material was Gram-negative except during reduction; it may be attained by hematoxylin. Beebe noted a condensed mass of nuclear material in the vegetative cells of Muzococcus xanthus that divided by constriction prior to each cell fission. Nuclear division is considered to be nonrandom amitosis Cell division is by means of constriction at a point near the center and is always complete. The nucleus is attained by gentian violet and by iron-hieratownin and gives a faintly positive Feulgen reaction. What appears to be an autogamous fusion of chromosomes takes place during sporulation, followed by a nuclear division during germination of the spores The spores germinate by a process analacous to budding Value (Cent f Bakt . II Abt . 25, 1909, 178) found fat globules and occasional small volutin granules in 3 to 4 day old cultures. Giveogen was not found.

In masses the vegetative reds may be somewhat reddish in color. That ter suggested the possibility that the color might be bacteriopurpurin. Treated with concentrated suffurie acid the pigment gives a blue reaction, hence Jalin (1921, lee. cit.) concludes it to be cause in

Motility of the cells. Bour (loc cit) states that cells have a power of forward movement at a rate of about 10 microns per minute. No flagella are present. The cells do not "awim"? They may bend and are unlike most true lacteria in this respect, though Dobell (Quart Jour of Microscop Science, 60, 1911, 993 and Arch I Protistendande, 60, 1912, 1917 describes such flexibility for the givin bacteria (see Bacillus fixibis). This is characteristic also of Begginston, Oscillatoria and Smiochotta.

The cells en mass move in a "front," advancing and leaving behind a alime. The cells in general tend to lic on rather than in the alime. The exact mechanism of motion has proved puzzling. Jahn believes the motion to be related to that of forms like Oscillatona, and to be due to exerction of alime from the cell, probably an asymmetrical exerction which pushes the cell along.

The colony. This has been variously termed a swarm, peculoplasmodium, plasmodium and reproductive commanism. It bears a family superficial resemblance
to the plasmodium of certain of the slime modes (Myzomycetes) but differs in that the
true plasmodium is composed of the fused lodies of large numbers of amoelood cells.
The mysobacterial colony is an aggregation of individual rad-singed, bacterial cells
that are not amoeloid. The slime produced by the cells is not protoplasmic, and the
colony is not motile but increases in size as the cells more away from the center.

and the second control of the second con-

Thavter proposed the term "pseudoplasmodium" as a satisfactory descriptive name for the vegetative colony, while Jahn preferred the use of "swarm stage." Inasmuch as the term "colony" in relation to bacterial growth implies large numbers of vegetative cells developing as a unit without regard for size, shape or structure, it is epaily suitable. Stanier (Bact. Rev., 6, 1942, 183) speaks of the condition as "reproductive communalism."

Pigmentation of the fruiting bodies is commonly employed in the differentiation of species. Species that produce coloriess systs and some with black pigment have been reported; in general the fruiting bodies are brightly colored in shades of yellow, red, orange or brown. The color seems to originate in the slime or cyst walls rather than in the encysted cells; its nature is not well understood. The Krzemieniewskis (Bull, Aead Polon, Sci. Lettres, Classe Sci. Math, Nat., Sci. R., Sci. Nat., J. 1337, 11) noted that the orange-red fruiting bodies of Sorangium compositum became gray-brown in strong alkali; the pigment was highly soluble in acetic acid and alcohol and easily soluble in ether and chloroform. It was insoluble in benoil, carbon disulfide and petroleum ether. They suggested that it was a carotin derivative rather than true carbin.

Beebe (1941, loc. cit.) found that the pigments of Polyangium fuscum, Podangium ercelum, Myzococcus virescens, Chondrococcus diasticus and Myzococcus ranthus gave typical carotin reactions in concentrated sulfurie acid, but were insoluble in chloroform, ether, acotone and methyl and ethyl alcohol. An atypical carotin resulted with hydrochloric and nitric acids. He concluded the pigments to be robated to the carotins.

The fruiting hodies. After growth as a vegetative colony the pseudoplasmodium usually forms fruiting bodies which may in the different species be of many shapes and sizes. Differentiation of species, genera and families is hased almost entirely upon the character of fruiting body developed. In some cases a stalk is produced, in some not.

In some forms the stalk is delicate and white, consisting of little-changed slime, in other cases it may be still and colored. The rods evidently are carried up by the slime which they secrete. In some forms the stalk is simple and short, in others relatively long and branched.

The rods ordinarily associate in more or less definite clumps to form cysts. These cysts may be sessile or stalked. Usually the rods shorten and thicken materially before the cyst ripens. In some forms they shorten so much as to become short ovoid or cylindrical, functioning as spores. They are not endospores such as are found in the genus Bacillus.

The cysts may or may not possess a definite membrane produced from slime. Usually the cysts are bright colored, frequently red, orange or yellow. The spores nithin the cysts when dried retain their valuity for considerable periods of time. Jahn records germination of Polyanguam fuscum after 52 years, of Myzococcus fulcus after

8 years. Methods of isolation. One technic of isolation used by the Krzemieniewskis (1927, loc. cit) was to sieve the fresh soil, place it on blotting paper in petri dishes, and add sterilized rabbit dung. The soil was saturated with water to 70 to 190 per cent, and the plates incubated at 25° to 30°C. After 50 to 10 days fruiting bodies began to appear on the dung. Numerous species were isolated by this method.

to appear on the dung. Numerous species were soluted by the Mishustin (loc cit) employed suita gel plates on the surface of which sterilized filter paper had been placed. Small lumps of soil were placed on the filter paper and the plates incubated for several days at various temperatures. Vegetative myxotice of the plates incubated for several days at various temperatures.

bacterial colonies developed around the inocula and were purified by transfer to fresh cellulose plates

Beebe reported a modified Krzemieniewski technic to be satisfactory. Fruiting bodies that had developed on sterilized rabbit dung were transferred to bacterial suspension agar plates. Associated bacteria failed to grow well, but myvobacteria developed rapidly.

The species of the genera Cytophaga and Sporcestophaga require special technics (Stanner, Bact Rev., 6, 1942, 143). The soil forms which decompose cellulose may be enriched with a medium consisting of cellulose (usually in the form of filter paper) and a neutral or slightly alkaline mineral base containing either ammonium or nitrate saits as nitrogen source. For certain species chitin may be substituted for cellulose Pure cultures may be secured by use of soft sagar (I per cent or less) with finely divided cellulose or with cellulose detritins (Fuller and Norman, Jour. Bact., 46, 1943, 281).

Guitivation of organisms. Pure cultures of many species have been grown upon various media and substrates Sterdized dung, dung decoction agar, nutrient agar, potato and potato agar, eternitzed hechens, etc have all been used Little study has been made of the food requirements. Recent evidence indicates the utilization of some of the more complex earbobydrates. Insiences hand Sointervas (Microbiology, Moscow, 6, 1937, 3) reported the growth of certain species on cellulose with partial decomposition of that compound Missibustion (Microbiology, Moscow, 7, 1938, 427) siolated five species of cellulose-decomposing myrobacteria, cultivating them on a mineral salt-sules gel medium to which filter paper had been added as a source of carbon. Kiremieniewska (Acta Soe Bot Folon, 7, 1930, 507) grow species of the Cupohagogeaco in cellulopiane, while Stapp and Bortels (Cent. f. Blat. II Mht., 20, 1931, 28) record the growth of other members of the same family on media containing

extract to be the only sultable nitrogen sources for the Cytophagacaca, inorganic salts and amino acids failing in this respect. Agar and cellulose are decomposed, while chitin and sharely were not utilized. Johnson (Jour. Bact., 24, 1932, 333) and Benton (Jour. Bact., 24, 1932, 343) had benton (Jour. Bact., 24, 1932, 343) had benton (Jour. Bact., 24, 1933, 344) both reported chitmovorous myvolacteria. Beebe (Iowa State Coll. Jour. Sci., 15, 1911, 319 and 17, 1913, 227) claimed growth of species of Polyanguam, Polanguam, Chondroseceus and Myrococcus on 1,5 per cent agar with no other mitrents added. Peptone appeared to aid development, while the addition of leafer extract had no favorable effect. Moderate growth occurred on a mineral saltagar inclum without the addition of various complex carbohydrates including cellulose and starch, the latter being by dmly red, complete inhibition resulted with pentores and hexores Best growth was reported on a niculum composed of dired betterial cells suspended in 15 per cent at air. The suspended cells were bysed by the tays soluterial.

The Kremmenewskis (Acta See Bot Pol. 5, 1927, 102) showed that the optimum hiddingers ion concentrations for growth of different species were found between pil 36 and Su. Becke 1991, be cut I reported to growth of any species below pil 60, while moderate development was noted up to pil 90.

Habitat and distribution. Many species have been described from dung. The work of the Kerementewskie (Acta See But Pol. 5, 1927, 192), Midmettin (Merobology, Moscon, 7, 193, 427), Indenech and Schitters (for et) and others seem in indicate that they occur commonly in soils, particularly soils under cultivation or high in organic nuterials. Different species appear to be characteristic of various

types of soils. Polyangium cellulosum var. ferrugineum Mishustin and Polyangium cellulosum var. fuscum Mishustin (loc. cit.) were observed to be common in the black soils of Eastern European Russia, while a similar variety of the same species was reported only from podzol soils. Species of the families Polyangiaceae, Sorangiaceae and to a lesser degree Archangiaceae appear to predominate in Russian and European soils, while the soils of Central and Western United States seem to he more suitable for the growth of the Myzococcaceae. Soils of mountainous regions are said to contain fewer numbers of myxobacteria than those of lowland areas.

The distribution of myxobacteria in the soil seems to show a relationship to the hydrogen ion concentration. Some species are found only in neutral or alkaline soils (pH 7.0 to 8.0), others only in acid soils (pH 3.6 to 6.4). Some species show a wide tolerance (pH 3 6 to 8.0).

Relationships of the Myrobacteria. The resemblance of the pseudoplasmodium of the myxobacteria to the plasmodium of the slime molds is as noted above probably to be regarded as without significance, as is also the superficial resemblances of the fruiting bodies of the two groups. Jahn (1924, loc. cit.) dismisses the relationship to the Thiobacteriales suggested by Thatter as improbable. Thatter believed the pos session of the red color might show presence of bacteriopurpurin; but Jahn found a carotin reaction which argues against this idea. Jahn insists upon a close relationship to the blue-green algae, particularly because of the mobility of the cells and the creeping motion. He does not believe all Schizophylae that do not belong to the Cuanophyceoe (blue-green algae) should be grouped as bacteria. He believes the myxobacteria to he more closely related to the blue-green algae than to the true bacteria, and creates the class Polyangidae to be coordinate with the class Schizomyette In this be ignores the count evidence of close relationship of the sulfur bacteria to the Cyanophyceae. His argument would lead to the recognition of all the orders of bacteria recognized in this MANUAL as classes. The wisdom of this is not apparent. The Muzobocteriales may be regarded as a well-differentiated order of the Schizemyccles showing some resemblance to the true bacteria on the one hand end the Myrophycege (Cyanophyceae) and Thiobacterioles on the other.

Families of the Myzobacteriales. The division of the order Myzobacteriales into families has been based, in all classifications proposed, upon morphology. The final demonstration by Stanier (Jour. Buct., 40, 1940, 636) of the close relationship between species of the genus Cytophaga and the myxohacteria led bim to propose the recognition

of a new family, Cytophagaceae

The principal character differentiation this family from the four previously recognized is the absence of differentiated fruiting bodies. The resting cells are rod-shaped ia the genus (Cytophaga). In another genus recognized by Stanier (Sporocytophaga) the resting cells are spherical. This brings the taxonomist face to face with the problem of deciding whether the presence of fruiting bodies or the spherical shape of the spores should be the primary basis of differentiation. The formation of enhanceal spores is believed to be of sufficient significance to require the inclusion of -- Sporocytophaga, although

s family, while those forms

which produce neither spherical spores not tracting .. dies (genus Cytophaga) are .. - -- family Cutophagaceae.

rods with ends almost truncate, and wag, orenes. cases with pointed tips) is supported by Stanier (Bact. Rev., 6, 1942, 143) as also the conclusion that the family Archangiaceae should be abandoned (Krzemieniewski and Krzemieniewska, Bull. Acad. Pol. Sci. Lettres, Classe Sci. Math. Nat., Scr. B., Sci. Nat., 1, 1937, 11-31) and the genera and species redistributed. The valuity of the argument is accepted, but the family is retained until a estisfactory revision can be effected. This should be based on a careful comparative study of the species

#### Key to the Families of Order Myxobacteriales.

- I. Neither definite fruiting bodies (cysts) nor spores (microcysts) produced.

  Family I Cytophagaccae, p 1012
- Spores (resting cells, microcysts) produced.
   A. Resting cells (spores, microcysts) clongate, not spherical or ellipsoidal
  - ing bodies (cysts) produced

    1 Fruiting bodies (cysts) not of definite shape; cells bean up to produce
    - 1 Fruiting bodies (cysts) not of definite shape; cells beap up to produce mesenteric masses or finger-like (columnar) bodies, Family II. Archangaecae, p. 1017.
    - 2 Truiting bodies (cysts) of definite shape
      - a. Cysts usually angular. Vegetative cells usually thick and short, with blunt, rounded ends.
      - Family III Strangiaceae, p. 1021

        aa Cysts usually rounded. Vegetative cells long and thin, cometimes
        spindle-shared with pointed ends
  - Family IV Polyangiaceae, p 1023
    R Resting cells (spores, microcysts) spherical or ellipsoidal Fruiting bodies
    - produced except in genus Sporocytophaga

      Family V. Myzococcaccae, p. 1010.

#### FAMILY I. CYTOPHAGACEAE STANIER.

(Jour. Bact., 49, 1949, 630.)

Flexible, sometimes pointed rods, showing creeping motility. No fruiting bodies or spores (microcysts) formed. There is a single genus Cytophaga.

> Genus I. Cytophaga Winogradsky. (Ann. Inst. Pasteur, 45, 1929, 578.)

Diagnosis: As for family. From Greek kytos, hollow place or cell; and phagein, to eat, devour.

The type species is Cytophaga hutchinsonii Winogradsky.

### Key to the species of genus Cytophaga.

- I From soil.
  - A. Do not utilize starch.
    - 1. Produce yellow pigment on cellulose.
      - 1. Cytophaga hutchinsonii.
      - 2. Cytophaga lutea.
    - 2. Produces orange pigment on cellulose.
      - 3. Cytophaga aurantíaca.
    - 3. Produces pink pigment on cellulose.
      - 4. Cutophaga rubra.
    - 4. Produces olive-green pigment on cellulose. 5. Cytophaga tenuissima.
  - B. Utilize starch.
- 1. Produces yellow to orange pigment on starch. 6. Cutophaga deprimata.
- 2. Produces cream to pale yellow pigment on starch. 7. Cytophaga albogilea.
- II From sea water.
  - A. Dark pigment on cellulose
    - 8. Cytophaga krzemieniewi ae.
  - B. No pigment on cellulosc.
- 9. Cytophaga diffuens.
- C Liquefies agar.
  - 10. Cytophaga sensitiva.

 Cytophaga hutchinsonil Winogradsky. (Winogradsky, Ann Pasteur, 43, 1929, 578; Cytophaga strain 8, Jensen, Proc. Linn. Soc. N. S. Wales, 65, 1940, 547; not Cylophaga hutchinsons Imšenecki and Solntzeva, Buil. Acad. Sci U.S.S.R., Ser. Biol., No. 6, 1936, 1129.) Etymology: Named for H. B. Hutchin-

son.

Rods: Highly flexible, occurring singly. 0.3 to 0.4 microns wide at the center and tapering to both ends Length 3.0 to 6.0 microns, according to Krzemienienska (Arch. Mikrobiol., 4, 1933, 396); 1.8 to 4.0 microns, according to Jensen (loc. cil.) May be straight, bent, U-shaped or Sshaped Stain poorly with ordinary aniline dyes. With Giemsa's or Winegradsky's stain young cells are colored uniformly except for the tips, which remain almost colorless; in older cells there is a concentration of chromatin material at the center. Old cultures show large coccoid cells which are not readily seen. Gram-negative.

Growth on collulose, cellobiose, cellulose dextrins and glucose. On mineral salts-silica gel plates covered with filter paper, bright yellow glistening mucilarinous patches are produced after a few days. The filter paper in these regions as gradually completely dissolved and the patches become translucent.

Ammonia, nitrate, asparagia, aspartic acid and peptone can serve as sources of nitrogen, according to Jensen (loc cit.).

Strictly acrobic.

Optimum temperature 28° to 30°C. Source: Isolated from soil.

Habitat Soil. Decomposes plant residaes

Cytophaga lutea Winogradsky. (Ann. Inst. Pasteur, 43, 1939, 599 )

Etymology: Latin luleus, yellow. Dimensions of the cells approximately those of Cytophaga aurantiaca (see below) but rather larger and thinner and without central an elling. Grammarked negative.

Produces a brilliant vellow pigment similar to that of Cylophaga hutchingonis. This species differs only in size from Cytophaga hutchinsoni, and is probably a

variety of it.

Source Isolated from soil. Habitat Soil. Decomposes plant residues.

Cytophaga aurantiaca Winogradsky. (Ann. Inst. Pasteur, 45, 1929, 597; pmbably Mycococcus cytophagus

Bokor, Arch, Microbiol . 1, 1930, 31 ) L'tymology Modern Latin aurantiacus, orange-colored.

Cells t 0 micmn wide at the center by 6 to 8 microns long | Except for size, very similar to there of Cytophaga hutchingonia Gram negative

Produces orange mucilaginous patches on filter ouper-silica gel plates. Fibrolyers is very rapid and intense

Source · Isolated from soil. Habitat: Soil. Decomposes plant residaes.

 Cytophaga rubra Winogradsky. (Ann. Inst. Pasteur, 45, 1929, 598.)

Ctymology: Latin ruber, red.

Pointed rods, straight or sometimes slightly bent, occasionally hooked at one end. Length approximately 3 microus. Gram-negative.

Produces diffuse, rapidly-spreading, pink to brick-red patches on filter paperailiea gel plates. Fibrolysis is much slower and less extensive than that caused by Cytophaga hutchinsonii.

Source: Isolated from soil.

Habitat : Soil Decomposes plant residues.

5 Cytophaga tenulssima Winogradsky. (Ann. Inst. Pasteur, 45, 1929, 509; incorreetly spelled Cutophaga ternissima in Bergey et al., Manual, 4th ed., 1934, 559 )

Etymology: Latin tenuissimus, most tenuous, very slender.

Dimensions of cells not given, but described as being extremely slender. Gram-negative.

Produces mucilaginous, greenish to olive patelies on filter paper-silica cel

Source. Isolated from soil.

Habitat: Soil. Decomposes plant residucs.

6 Cytophaga deprimata Fuller and Norman (Jour. Bact., 45, 1943, 566.) Livmology: Latin deprime, to depresa

or sink down.

Rods. Long and flexuous with pointed ends, 0.3 to 0.5 by 5.5 to 10 micmas. arranged singly Creening motility on polid surfaces. Gram-negative.

Growth on starch near is at first smoke to faint vellow becoming bright vellow later Colonies are irregular and concave in elevation. The edge aprends indistinguishably into the surrounding medium and shallow depressions develop around the colony Small colonies give the plate a characteristic pitted appestance.

Gmwth on rellulose destrin agar to

milky white. Colonies are depressed in medium.

Gelatin is liquefied in 4 days.

Glucose, lactose, maltose, sucrose, pectin, starch, cellulose dextrin and hemicellulose are utilized. Very seant growth on cellulose may be found on first isolation.

Yeast extract, ammonium nitrate and peptone are suitable nitrogen sources.

Indole not formed.

Nitrites not produced from nitrates. No visible change is litmus milk. Highly aerobic.

Optimum temperature 25° to 30°C. Source: Isolated from soil.

Habitat: Soil. Decomposes organic matter.

7. Cytophaga albogliva Fuller and Norman (Jour. Bact., 45, 1943, 566.) Etymology: Latin albus, white, and

gilvus, palo yellow.

Long flexuous rods with pointed ends, 0.3 to 0.5 by 4.5 to 7.5 microns, arranged singly. Creeping motility on solid surfaces. Gram-negative.

Growth on starch agar is cream to pale yellow. Colonies are small, concave, and irregulary round. Edge is entire and irregular

Growth on cellulose dextrin agar is restricted. Colonies are pin-point. milky white in color, round and concave.

Gelatin is liquefied in 7 days. Glucose, galactose, lactose, maltose, sucrose, gum arabic, pectin, starch, collulose dextrin and hemicellulose are utilized. Very scant growth on cellulose

may be found on first isolation. Ammonia, aitrate and peptone are

suitable nitrogen sources. Indole not formed.

Nitrites not produced from nitrates. No visible change in litmus milk

Highly aerobic.

Optimum temperature 22° to 30°C Source: Isolated from soil. Habitat: Soil. Decomposes organic matter.

Cytopbaga krzemienicwskae Stanier. (Incorrectly spelled Cytophaga Arzemieniewskii in Stanier, Jour. Bact . 40, 1940, 623; Jour. Bact., 42, 1941, 532.)

Etymology: Named for H. Krzemieniewska.

Long, flexible rods, usually of even width with blunt ends, occasionally somewhat pointed and spindle-shaped. 0.5 to 1.5 by 5 to 20 microns. Starshaped aggregates occur in liquid media. Creeping motility on solid surfaces, non-motile in liquids.

Growth on a sea water-peptone agar plate begins as a smooth, thin, pale pink, rapidly spreading swarm. After a few days, the older portions of the swarm assume a warty appearance due to the accumulation of cells in drop-like masses, resembling immature fruiting bodies but always containing normal vegetative cells. A diffusible brown to black pigment which masks the pink color of the swarm is produced after about a week. Agar is rapidly decomposed, and ultimately liquefaction becomes almost complete.

Sea water-gelatin stab: Liquefaction Growth in liquid media is turbid and silky with a pink sediment; the medium turns dark brown or black after 1 or 2 wecks.

Xylose, glucose, galactose, lactose, maltose, cellobiose, cellulose, alginic acid, agar and starch are utilized, but not arabinose, sucrose and chitin.

Yeast extract and peptone are the only suitable nitrogen sources known.

Weakly catalase positive.

Indole not formed.

Nitrites produced from nitrates. Hydrogen sulfide not produced.

Salt concentration range: 1.5 to 50 ner cent.

Strictly nerobic.

Optimum temperature 22° to 25°C. Source: Isolated from sea water. Habitat: Sea water. Probably on decaying marine vegetation.

9. Cytophaga diffluens Stanier. (Jour. Bact., 40, 1910, 623; Jour. Bact., 42, 1911, 546.)

Etymology. Latin diffuens, spreading,

flowing away.

Pointed, sometimes epindle-shaped, flexible rods, 0 5 to 1 5 by 4 to 10 microns. In old cultures involution forms consisting of long, twisted, thin threads are found. Star-shaped aggregates of cells occur in liquid media. Creeping motility on solid surfaces, non-motile in liquids. Growth on a sea water-preptione agar.

plate begins as a thin, pink, rapidly spire-ding swarm which often covers the entire surface in a few days. The swarm gradually increases in thickness and develops an irregular, beaten-copper surface due to the liquefaction of the underlying agir. After 4 to 5 days the color becomes orange. Liquefaction of the flagar is ultimately almost complete. See water-gelatin stab. Rapid liquefaction of

faction
Growth in liquid media is turbed, often

with suspended floccules and a heavy pollicle

Mylose, glucose, galactose, lactose, maltase, cellobose, cellulose, agar and alginicacidarcutilized, but not arabinose, sucrose, cluitin or starch.

Yeast extract and peptone are the only autable nitrogen sources known.

Weakly catalase positive

Indole not formed

Natrates produced from natrates. Hydrogen sulfide not produced

Salt concentration range 1.5 to 50 per cent

Slightly acrobic

Optimum temperature 22° to 25°C Source Isolated from sea water Habitat: Sea water. Probably on decaying marine vegetation.

10 Cytophaga sensitiva Ifumm (Duke Univ Manne Lab, North Caroina, Bull 3, 1916, 61) Etyomology Latin resure, to perceive

Cells long, stender, flexuus rods

Apparently not flagellated, 08 to 10 by 7.0 to 20 mierons Cell ends not tapered or only slightly so. Gramnegative. Cells exhibit creeping motility on agar with ability to reverse direction of movement without turning. Bending movements occur in liquid media

Colonies hight orange, thin and shin-Irregular margin. Outer part composed of a single layer of cells, apreading rapidly, the center somewhat thicker and more or less opaque, sunken in the agar. Agar liquefied. Single colony may nearly cover the surface of the agar in the Petri dish within one week, center of colony sinks to the bottom of the dish and may develop vertical sides. Usually the colony begins to die after a neek or ten days from the center outward, as shown by loss of nigment. Apparently no water-soluble pigment is produced Colony 18 mm in diameter and gelase field 25 mm in diameter after three days on agar containing 0.8 per cent potassium nitrate and 0 8 per cent pentone (sodino stain)

Gelatin No growth.

Milk. No growht

Nitrate apparently not produced from nitrate (agar medium)

Optimum nitrate concentration of medium appeared to be 0.5 per cent. Fair growth on sea water plus agar only, and on agar containing 10 per cent potassium nitrate Slight growth on 20 per cent nitrate agar.

Optimum peptone concentration appeared to be about 0.1 per cent; growth inhibited by concentrations of peptone exceeding 0.4 per cent No growth on agar media containing

any one of the following substances in a concentration of 0.2 per cent glucose, starch ammonium sulfate. The hasd medium, however, supported excellent growth.

Hepeated efforts were made to obtain a pure culture by streaking plates and by pouring plates. These were finally sue cessful by the use of an agar medium that contained 01 per cent peptone, 005 per cent beef extract, 0.05 per cent glucose, and traces of yeast extract and ferric phosphate. Good growth on broth of this composition was also obtained. Apparently the yeast extract supplied necessary growth substances.

Source: Isolated September 19, 1915 from a mixed culture with Pseudomonas corallina, by streaking a piece of Dictyota dichotoma on agar containing 0.2 per cent potassium nitrate.

Habitat: From scaweed. Beaufort, North Carolina.

Appendix: Stapp and Bortels (Cent. f. Bakt., II Abt., 90, 1934, 28) described four new obligate cellulose-decomposing species: Cytophaga silvestris, Cytophaga anularis, Cytophaga flavicula and Cytophaga crocea. The differences between them are small and, while it is impossible to make positive identifications on the basis of present knowledge, they seem to be very similar to Cutophaga hutchinsonii. In the absence of comparative pure culture studies on the obligate cellulose-decomposing members of the genus, the proper delimination of species is not possible. Their inclusion in keys must await additional information

#### FAMILY II. ARCHANGIACEAE JAHN.

(Beiträge zur botan. Protistologie, I. Die Polyangiden. Geb. Borntraeger, Leipzig, 1924)

In the organisms belonging to this family the swarm (pseudoplasmodium) produces irregular swallen or twisted fruiting bodies, or develops columnar or finger-like growths, usually without a definitely differentiated membrane.

### Key to the genera of family Archangiaceac.

I Fruiting body depressed, usually irregularly delimited, the interior usually consisting of swollen or intestine-like twisted or inter-twined masses, whose windings may be constricted or may fut out (roughed) as free ends.

Genus I Archangum, p. 1017.

II Fruiting body consists of single (separate) columnar or finger-like structures arising from the substrate

Genus II. Stelangium, p. 1020.

#### Genus I. Archanglum John.

(Jahn, Beiträge zur botan Protistologie, I. Die Polyangiden Geb Borntraeger/ Leipzig, 1921, 67 (ophicogista Enderlein, Bermerkungen zur Systematik der Chondromyeuden, Berlin, 1921, 6 pp.)

Etymology: Greek arche, primitive, and angion, vessel (according to Jahn, this

genus is the most primitive).

The mass of shortened rods embedded in slime forms a pad-shaped or more rounded, superficially swellen or tuberous fruiting body, even with horny divisions. The fruiting body has no membrane. In the interior can be seen a mass resembling could intestines. The windings of this coil may be uniform, or irregularly jointed, free or stuck together; the ends may be extended and horny. Instead of a membrane there may be loosely enveloping slime.

The type species is Archangium gephyra Jalin

### Key to the species of genus Archanglum.

I. No slimy capsules.

- A. Fruiting body usually wound, irregularly constricted, sometimes swollen and vesicular, appressed
  - 1. Fruiting body red.
    - a The shortened rods 25 to 3 nucrons
    - 1 Archangium gephyra
      as. The shortened rods 4 to 6 microns
  - 2 Archangium primigenium
    2 Fruiting body vellow.
  - 2 Fruiting body yenow.
- 3 Archangium flatum.
- B Tube usually uniformly thick, loosely wound, often branched.

  4. Archangium scrpens
- 11 Fruiting body romaisting of a reddish rolled tube, embedded in yellow slime.

  5. Archangiant thazters.
- Archanglum gephyra Jahn. (Chon-botanischen Protivologie. 1 Die Polydeorgers aerpens Quebl, Cent f. Bakt., anglein, Geb Borntraeger, Leipzig, II Abt. 16, 1934, 16, Jahn, Bettrige ur. 1921, 67.

Etymology: Greek gephyra, a bridge. So named because a transition form between the Archangiaceae and the Myzococcaceae.

Swarm stage (pseudoplesmodium): Grows easily in manure decection, forming a pseudoplesmodium and ring of fruiting bodies. The vegetative rods are about 10 microns long, 0.5 micron in diameter.

Fruiting bodies: Up to 1 mm in diameter, of irregular form and with swollen or padded surface. Average sized fruiting bodies are a reddish flesh color by reflected light; smaller fruiting bodies, n light rose. On a dark background large fruiting bodies when fresh appear bluish violet. By transmitted light the fruiting bodies appear yellowish to light red. Upon addition of alcohol or when heated in glycetine, they lose the color quickly and uppear gray or colorless.

The inner structures are for the most part a mesenteric mass of tubes 40 to 60 microns wide, without any membrane, and without any enclosing slime. The convolutions are often pressed together. On the inside of these tubes there appears definitely a septation by straight or slightly arched cross walls which, bowever, do not always out entirely through the spore masses from one side of the tube to the other. Upon pressure, the fruiting body breaks up into a number of small fragments about 15 to 30 microns in diameter. Within these fragments the shortened rods lie parallel and in bundles.

The rods in the fruiting bodies are so shortened that they resemble the spores of the Myzococaccac. The spores are 2.5 to 2.8 microns long and about 1.4 microns wide. Often they are somewhat bent so that they appear to be bean-shaped. In the smooth, transparent tips of fruiting bodies they stand closely parallel to each other, so that in transmitted light one sees only their cross section and is at first led to believe that

he is dealing with one of the Myzo. coccaccae.

Source and habitat: Found frequently in the region of Berlin on the dung of deer, rabbits, and hare, once also on old decaying lichens. Easily overlooked on necount of its usual bluish color. According to Krzemieniewski (1927) the most common of myxobacteria in the soils of Poland. Isolated on rabbit dune.

Hustrations: Queld (loc. cit.) Pi. 1, Fig. 7. Jahn (1924, loc. cit.) Pl. 1, Fig. 5 Krzemieniewski, Acta Soc. Bot. Poloniae, 4, 1926, Pl. III, Figs. 25-26.

 Archangium primigenium (Quehl) Jahn. (Polyangium primigenium Quehl) Gent. f. Bakt., II Abt., 18, 1906, 16, Jahn, Beitrige zur botanischea Protistologie. I. Die Polyangiden, Geh. Borntrager, Leipzig, 1923.)

Etymology: Latin, primigenius, primitive, referring to the simple and primitive character of the fruiting body.

Swarm stage (pseudoplasmodium): In manure decoction cystsgerminatereadily. Vegetative rods 4 to 8 microns is length

Fruiting bodies: Up to 1 mm in diameter, sometimes larger, with irregularly padded swollen surface; when fresh a lively rod color which is quite prominent especially against a dark background; when dried, dark red. In transmitted light flesh red to yellowish red In alcohol and upon heating it is quickly bleached.

In transmitted light one sees that the fruiting body is made up of aumerous intestine-like convolutions closely appressed, not however, always definitely delimited. These tubes usually have a diameter of from 70 to 90 microns, often constricted and attenuated. No membrane is present. The rods in the fruiting bodies are about 4 microus long and 0.8 micron wide. Upon pressure on the fruiting bodies, the rods remain together in small fragments of various sizes.

2a. Archangium primigenium var.

assurgens Jahn. (Jahn, Beiträge zur botanischen Protistologie. I. Die Polyangiden, Geb. Borntrager, Leipzig, 5, 1924, 69; Archangium assurgens Krzemieniewski, Acta Soc. Bot 'Polomae, 1927, 95.)

Etymology: Latin assurgers, rising up Sire and color of the fruiting body as in the species, likewise the inner structure, size and arrangement of the rods. However, the tubules which together constitute the fruiting bodies are more or less Iree at their ends and stand up from the substrate. Their diameter is somewhat less (about 15 microns), they are often convoluted so that they many times appear to be constricted (die pearls).

Pronounced races of the species and of the variety are so different in habits that they may be regarded as distinct species. Jalin believes the presence of intermediate strains makes a separation

difficult

Source and habitat: According to Jalin, Archangum principenum is not particularly common it is usually lound on rabbit dung, cometiness on roe dung. The vancty assurgens is relatively rare (found three times on rabbit dung). Koller (1930) on rabbit dung, Vienna Very rare in Polish soils according to Kircmeniewski (1927).

Illustrations Quebl, Cent. I Bakt, 11 Abt. 1d., 1906, 16, Pt. 1, Pg. 5, Jahn, Kryptogamenfort d Mark Brandenburg, V, Pufre I, Left 2, 1911, 201, Pt. 1, Fig. 5, Jahn (1921, for ett.) Pt. 1, Fig. 4, also Fig. G, page 37, Kremienerwski 1925, for ett.) Pt. IV, Fig. 3 vor. dasurgens, Pt. IV, Fig. 1 and 2.

3 Archangium flavum (Kufler) Jahn (Polyan)am flavur Kofler, Sitzber d Kaisa Akal Wiss Wien Math. Nat Klasse, 122 Mt. 1913, 861, Jahn, Beitrige zur botanischen Philistologie I Die Polyangiden, Gels Borntraeger, Leipzig, 1921, 71) Etymology: Latin flavus, golden or reddish-vellow.

Swarm stage (pseudoplasmodium): Not described.

Fruiting bodies: About 0.5 mm in diameter, yellow, spherical or oval, with humped or pudded surface. The mass of cells quite homogeneous, upon pressure under cover glass single sections tend to addiere. No membrane, though the rods are so tightly linked that when eautiously placed under a cover glass, the form of the fruiting body is retained. Rods 2 to 4 microns.

Source and habitat, Kofler (1924) on hare dung found in Danube meadows. Reported as frequent in Polish soils by Krzemieniewski (1926, 1927).

Illustrations: Krzemieniewski, Acta Soc Bot Poloniae, 4, 1926, Pl. II, Fig 21 (1927), Pl. IV, Fig. 4, 5 and 6.

4 Archanglum serpens (Thatter) Jahn. (Chondromyces serpens Thatter, Bot. Gar, 17, 1802, 403; Jahn, Beiträge sur botanischen Protistologie I. Die Polyanguden, Geb Borntraeger, Leipzig, 1921, 72)

Etymology Latin serpens, creeping Swarm stage (pseudoplasmodium); Rods cylindrical, 65 by 5 to 7 microns, Cultures on agar develop convoluted form.

Fruting body. Mont I man in disameter, recumbent, ensisting of numerous loosely intertwined systs, confluent in an anastonosing coil, flesh-colored, when dry drik red, 20 nurrons in disameter, beat, occasionally somewhat broadened or constricted, branched.

Source and habitat Tharter, Bot. Gaz, 17, 1872, 389 On decaying lichens. Cambridge, Mass

Illustrations Tharter (loc cit ), Pl. 21, Fig 21.

5 Arthangium thanteri Jalin. (licitrige zur lotanischen Protistologie I Die Polyangiden, Geb. Borntraeger, Leipzig, 1924, 71.)

Etymology: Named for Dr. Roland Thanter.

Swarm stage (pseudoplasmodium): Vegetative stages not observed. Either no germination or prompt cessation of growth on dung extract. May be transferred on dung

Fruiting body: Usually 0.25 to 0.5 mm, occasionally 0.75 mm in diameter. Irregularly rounded, superficially sulfur yellow. Upon pressure numerous reddish convoluted tubules are observed embedded in a yellow slime. The average diameter of the tubules is about 50 microns. No membrane surrounds the tubee. They contain the shortened rods.

The fruiting body is bleached by alcohol or heat, becoming yellowish. Enveloping slime is variable. In well developed specimens the slime forms a stalk, giving the whole the appearance of a morel. In small specimens the rods are embedded in the slime. The fruiting bodies stand loosely separated on surface of dung, never in large groups. Shortened rods (spores) 0.5 micron by 3 microns, very slender.

Source and habitat: According to Jahn rare, on rabbit dung. Races with well developed stalks even less common.

Blustrations: Jahn (loc. cit.), Pl. 1, Fig. 1 and 2. Krzemieniewski, Acta Soc. Bot. Polonice, 4, 1926, Pl. II, Fig. 27.

#### Genus II. Stelanglum Jahn.

(Kryptogamenslora der Mark Brandenburg, V, Pilze I, Lief. 2, 1911, 295.) Etymology: Greek etele, pillar or column and angion, vessel.

Diagnosis: Fruiting bodies are columnar or finger-like, sometimes forked, without definite stalk, standing upright on the substrate.

The type species is Stelangium muscorum (Tharter) Jahn.

 Stelangium muscorum (Thavter) Jahn. (Chondromyces muscorum Thavter, Bot. Gaz., 37, 1901, 411; Jahn. Kryptogamenslora der Mark Brandenburg, V, Filze I, Lief. 2, 1911, 205)

Etymology: Latin muscus, moss.

Swarm stage (pseudoplasmodium): Not described.

Fruiting body Bright yellow-orange,

90 to 300 microns long, 10 to 50 microns wide, mithout differentiated stalk, simple or rarely fureate, upright, elongate, compact or slender, narrowed at tip Rods (spores) 1 to 1.3 by 4 to 6 microns. Source and habitat: According to

Thaxter (loc. cit.) on liverworts on living beech trunks in Indiana.

Blustrations: Tharter (loc. cit.) Pl. 27, Figs. 16-18.

#### FAMILY III. SORANGIACEAE JAHN.

(Beitrage zur botan Protistologie I. Die Polyangiden. Geb. Borntracger, Leipzig, 1924, 73.)

Diagnosis. The shortened rods of the fruiting body lie in angular, usually relatively small cysts of definite polygonal shape. Often many of these cysts are surrounded by a common membrane. The primary eyst may be differentiated from the angular or secondary cysts. No stalked forms are known.

#### Genus I. Soranglum John.

(Jahn, Beiträge z. botan, Protistologie. I. Die Polyangiden, Geb. Borntraeger, Leidzig, 1921, 73; Custoecemia Enderlein, Bemerkungen z. Systematik d. Chondromyciden, Berlin, 1921, 73.)

Litymology · Greek soros, heap and angion, vessel

Diagnosis. As for the family The cysts are united into rounded fruiting bodies. Eight species have been allocated to this genus.

The type species is Sorgnounm schroeters Jahn.

### Key to the species of Genus Sorangium,

I. Fruiting bodies not black when ripe.

A Primary cysts absent; fruiting body shows only angular, spherical or oval small cysts

1 Cysts angular

- a Fruiting body very small (50 to 80 microns), often pregularly cerebriform; the angular cysts often completely separated from each other, and about 13 nucrons in diameter.
  - 1 Sorangium schrocieri

4a Pruiting body composed of many small cysts. b Cysts orange-red in color; over 50 mierons in diameter.

- 2. Sorangium sorediatum bb Rusty brown color; cysts less than 3.5 microus in diameter.
  - 3 Sorangium cellulosum.
- 2 Cysts spherical or oval.
  - 4. Sorangium spumosum.
- B Both primary and secondary cysts present.
  - 1 Primary cysts small and numerous, about 20 microns, with definite membrane and few angular secondary cysts.
  - 5 Sorangum sentatum. 2 Prunary cysts large, with delicate, often indefinite, membrane.
- 6 Sorangium compositum.
- II Fruiting bodies black or brownish black when ripe.
  - 1 Primary cysts generally not formed. 7. Sorangium nigrum.
  - B. Primary evets generally formed.
    - 8. Serangium nigrescens.
- I. Die Polyangiden, Geb. Borntraeger, I Sorangtum achroeteri Jahn (Jahn, Beitrige zur betanischen Protistologie. Leipzig, 1921, 73; regarded as a synonym

of Sorangium compositum by Krzemieniewski, Acta Soc. Bot. Poloniae, 5, 1927, 96.)

Etymology: Named for Julius Schroeter (1837-1894),

Swarm stage (pseudoplasmodium): Not described.

Fruiting bodies: Very small, circular, swollen, often kidney-shaped with hrainlike convolutions, usually 60 microns (occasionally 120 microns) in diameter, bright orange-red. Surrounded by a delicate slime membrane about 0.7 micron thick, apparent only with high magnifications. Divided secondarily into angular cysts, by sutures extending inward which divide the mass regularly into well delimited portions, many angled, usually about 12 microns ia diameter, and in other places into areas less well delimited and about 14 microns in diameter. Resembles gelatin which has dried in a sheet and cracked into regular areas. Rods in cysts 5 microns long. Cysts sometimes occur together in large numbers, covering an area to 0.5 mm.

Source and habitat Found by Jahn (loc cit.) five times on rabbit dung in environs of Berlin.

Illustrations · John (1924, loc. cit), Pl. 2, Fig 22.

 Sorangium surediatum (Thavter) Jahn (Polyangium sorediatum Thauter, Bot. Gaz. 57, 1904, 414, Jahn, Beitrage zur botanischen Protistologie I. Die Polyangiden, Geb Borntraeger, Leipzig, 1924, 73.)

Etymology From Greek, soros, heap, probably through the botanical term soredium, nne type of reproductive body in the lichen, and sorediate, with surface patches like soredia.

Swarm stage (pseudoplasmodium): Rods 0 8 by 3 to 5 microns Attempts to cultivate have failed.

Fruiting body. Orange-red, irregularly lobed, consisting of a compact mass of small angular cysts. Average size of cysts 6 to 7 microns, smallest 3 microns, with thick and sharply defined edges. Rods 08 by 3 to 5 microns. The Krzemicniewskis (1927, loc. cit., 96) have described a variety, Sorangium sorediatum var. macrocystum, consisting of cysts 6 to 14 by 7 to 16 microns, about twice as large as in the type.

Source and habitat: Reported once by Thaxter (loc. cit) un rabbit dung from South Carolina, Krzemieniewski (1927, loc. cit.) common in Polish soils.

Illustrations: Thaxter (loc. cil.) Pl. 27, Figs. 22-24. Quehl, Cent. 1. Bakt., II Abt., 16, 1906, 9, Pl. 1, Fig. 2. Jahn,

HAOL, 16, 1800, 9, 71. 1, Fig. 2. Jahn, Kryptogamen-flora d. Mark Brandenburg, V, Pilze I, Lief. 2, 1911, 202, Fig. 1. Krzemieniewski, Acta Soc. Bot. Pol., 4, 1926, Pl. IV, Figs. 39-41. (1927, loc. cit.) Pl. V, Fig. 17, var. macrocystum Fig. 18.

 Serangium cellulosum Imšenecki and Solntzeva. (Microbiology, Moscow, 8, 1937, 7.)

Etymology: Modern Latin cellulosum, cellulose.

Pruiting body: Mature fruiting body rusty brown, 400 to 500 microns in diameter, sessile on layer of partially dried slime. No nuter wall ne limiting membrane. Composed of numerous cysts, irregular in shape 1.6 to 3.2 microns in diameter, eat containing less than ten shortened rods. No discernable cyst wall or membrane.

Spores: 0.3 by 1.5 to 2.0 microns (no other data).

Vegetative cells: Flexible, rod-shaped cells with rounded ends, necurring singly; on flagella but metils by means of a crawling motion, 0.4 to 6 6 by 2.2 to 45 microns

Vegetative colony: No data.

Physiology: Good growth on stareb, cellulose. Decompose up to 21 per cent cellulose in ten days, but does not form fruiting bodies. Very poor growth on arabinose with formation of many involution forms including very much clongated

cells. Fail to grow on nutrient agar. washed agar, potato, earrot, milk.

Source: Isolated from soil Habitat: Soil, Decomposes organic

matter 4. Sorangium snumosum Krzemie-

niewski and Krzemienewska. (Acta Soc Bot. Poloniae, 5, 1927, 97.) Etymology: Latin spumosus, frotby or

foamv.

Swarm stage (pseudonlasmodium). Rods 0.7 to 0.9 by 2.6 to 5.2 microns Fruiting bodies: Consist of numerous

cysts, spherical or oval, not surrounded by a common membrane, but united into bodies embedded in slime Often in double or single rowa. Cyst walls colorless, or slightly brownish, transparent, so that the characteristic arrangement of the rods may be seen within Cysts 8 to 26 by 7 to 20 microns.

Source and habitat: Krzemieniewska (1927, loc. cit ) from Polish soil, isolated on rabbit dung.

Illustrations: Krzemieniewski (1927. loc. cit.) Pl. V. Fig. 19.

5. Sorangium septatum (Tharter) Jahn. (Polyangium septatum Tharter, Bot Gaz., 57, 1901, 412; Jahn, Bestrage zur botanischen Protistologie, I Die Polyangiden, Geb. Borntraeger, Leipzig, 1924, 75 )

Etymology: Latin saentatus, fenced, i.e., divided by walls

Swarm stage (pseudoplasmodium) Rods 0.8 to 1 by 3 to 5 microns

Fruiting bodies, Yellowish-orange When dried, dark orange-red, 50 microns to more than 100 microns in diameter, cysts rounded or ovoid, angular or extendrical, inner portion of the envelope divided into a variable number of eccondary cysts. Cysts 18 to 22 by 12 to 22 microns in diameter. Secondary cysts 10 to 12 microns. The Krzemieniewskis (1927, loc. cit., 96) recognize a variety, Sorangium septatum var. micro. cystum, which has secondary eysts with dimensions 4 to 10 by 3 to 8 microns.

Source and habitat: Collected twice (Thaxter, Bot. Gaz., 57, 1904, 412) on borse dung in Cambridge, Mass. Reported by Krzemieniewski (Acta Soc. Bot. Poloniae, 5, 1927) as common in Polish soil.

Blustrations . Thaxter (loc. cit ) Pl. 27. Figs 25-28 Jahn, Kryptogamen-flora d. Mark Brandenburg, V. Pilze I. Lief 2. 1911, 202, Fig. 2 Krzemieniewski, Acta Soc Bot. Pol., 4, 1926, Pl. 27, Figs. 27-38; abid , 1927, Pl. V. Fig. 15, var. microcustum, Fig. 16

6 Sorangium compositum (Tharter) (Polyangium compositum Thayter. Bot. Gaz. \$7, 1904, 413; Jahn. Beiträge zur botanische Protistologie I. Die Polyangiden, Geh. Borntragger, Leipzig, 1921, 74, Polyangium sorediatum Ouehl, Cent f Bakt . II Abt., 16, 1906. 17, not Polyangium soredigium Tharter,

Etymology: Latin compositus, comnound

Swarm stago (pseudoplasmodium) : Not described

Fruiting bodies · Dull yellowish-orange changing to dark red on drying. Rounded, emalt, 0 5 to 1 mm, usually as a whole or even in larger clumps surrounded by a delicate and evanescent membrane. In large fruiting boiles the eyets are bound together in balls 70 to 90 microns in diameter by a delicate membrane. The balls readily fall apart Secondary cysts are angular, 7 by 11 microns, surrounded by a delicate orange-red membrane, about 0.4 micron in thickness | Length of rods in the cysts 5 microns

Source and habitat Thaxter (loc. cit.) rabbit dung, South Carolina. Jalin (1901. toe cit ) found it four times on rabbit dung pear Berlin, and twice on hare dung in Oberharg Common in soils of Poland according to Krzemieniewski (1927, loc. est )

Illustrations : Thaxter (loc. cit.) Pl. 27, Figs. 29-30. Jahn (1924, loc. cit.) Pl. I. Fig. 6. Krzemieniewski, Acta Soc. Bot. Pol., 4, 1926, Pl. III, Figs. 32-36; ibid., 1927, 5, Pl. IV, I'sgs. 7, 8, 9, 19, 11, 12; Pl. V. Figs. 13, 14; Pl. VI, Fig. 36.

7. Sorangium nigrum Krzemieniewski. (Bull. Int. l'Acad. Pol. Sci. et Lettres, Classe Sci. Math. et Nat., Ser. B, 15, 1937.)

Etymology : Latin niger, black.

Fruiting body : Primary cysts generally not formed; when observed, appeared as smoke-colored slime envelope surrounding clumps of a few cysts. Secondary cysts usually arranged in rows within cellulose fibers, the material of the fiber forming a common sheath. Each individual eyst inclosed by a cyst wall, clearly differentiated from the tubularshaped cellulose fibers. Cysts measure 9 to 16 by 9 to 23 microns; average 10 by 18 microns. Cyst wall moderately thick, coloriess, transparent, becoming light brown with age, and finally black.

Spores: No data

Vegetative cells: 1.1 to 1.3 by 2.5 to 5.5 microns.

Vegetative colony: Young colonies dead black in color On filter paper a bright orange margin is noted, the veretative cells of which cover the cellulose fibers. On cotton cloth the margin is bright dirty-yellow, tinged with pink. Under low power magnification, center of the colony appears similar to matted fungal hyphae, due to characteristic compact accumulation of cysts and cellulose fibers.

Physiology: Cellulosc fibers become swellen by the action of this organism, and become gray-brown with a violet Fibers lose the properties of cellulose and give no characteristic reactions

Source . Isolated from soil.

Habitat: Soil. Decomposes cellulose fibers.

Illustrations: Krzemieniewski (loc. cit.) Plate IV, Figs. 22-26.

8. Sorangium nigrescens Krzemieniewski. (Bull. Int. l'Acad. Pol. Sci. et Lettres, Classe Sci. Math. et Nat., Sér. B. 15, 1937.)

Etymology: Latin nigrescens, becoming dark or black.

Fruiting body: Primary cysts vary in size up to 200 microns in diameter, irregular in shape and inclosed in a coloriess slime envelope. Formed by an accumulation of secondary cysts. Secondary cysts at first colorless, transparent, later becoming brownish with a limiting membrane; the young cysts appear dirty-yellow, the older ones grayishbrown to black. Color originates not only from the brownish cyst wall but from the gray mass of encysted cells. Secondary cysts measure 5 to 12 by 6 to 15 microns; average 6 by 10 microns. On filter paper not only well-formed primary cysts are formed, but also free secondary eysts are noted embedded in the slime of the colony.

Spores: No data.

Vegetative cells: 12 to 1.4 by 2.5 to 64 somewhat microns. Younger cells shorter.

Vegetative colony: Mass of dark fruiting bodies develops at center of colony on filter paper; margin grayish-yellow. Cellulose fibers covered with vegetative cells on outside, and contain many cells within.

Physiology: Destroys cellulose. Cultivated six years with cellulose as carbon

source. Source: Isolated from sandy soil in nine woods in Ciemianka (?).

Habitat: Soil. Decomposes cellulose

fibers. Hlustrations: Krzemieniewski (loc. cit.) Plate III, Figs. 17-21.

#### FAMILY IV. POLYANGIACEAE JAHN

(Beiträge zur botan, Protistologie. I. Die Polyangiden, Geh. Borntraeger, Leipzig, 1924.)

Diagnosis: In the fruiting bodies the more or less abortened rods tie in rounded cysts of definite form. The well-defined wall is composed of bardened stime, and is yellow, red or brownish. The eysts may be united by a definitely visible slime membrane, the remaint of the vergetative slime, or they may be tightly appressed and cemented by the scarcely visible remnants of the slime, or they may develop singly or in numbers on a talk. In the more highly developed forms the stalk branches and carries the cysts at the typs of the branches.

### Key to the genera of family Polyanglaceae.

- Cysts rounded, not stalked, usually many (one in Polyangium simplex) lying loosely in a slime membrane or closely appressed
  - Genus I. Polyangium, p. 1025.

- II. Cysts not as in I
  - A. Cysts pointed at the apex, often completely concreteent, and united to large disks or spheres
  - Genus II. Synangium, p. 1632.
    B. Cysts free, single or many on a stalk,
    - 1 Cysts forming a disk, firttened donoventrally, like the cap of a Bolcius, on a white stalk
      - 2. Cysts not forming a disk

a Cysts rounded or clongate, single on stalks.

Genus III. Melittangium, p. 1033 le on stalks. Genus IV. Podangium, p. 1031.

an Cysts rounded or clongate or pointed, numerous on the ends of stalks which may be branched

Genus V. Chondromyces, p 1036.

### Genus I Polyangium Link,

(Link, Mag d Ges Naturforech, Freunde zu Berlin, 3, 1819, 42, Cystobacter Schroeter, in Colin, Kryptogamensora v Schlesien, 3, 1, 1886, 170, Myzobacter Thayter, Bit Gaz, 17, 1872, 311

Etymology Greek poly, many and angion, vessels, referring to the numerous cysts Disgussis. Cysts rounded or conted, surrounded by a well-developed membrane, either free rembedded in a second simplifyer.

The type species is Polyangium ritellinum Link

### Key to the species of genus Polyangium.

- I. Not parasitic on water plants (algae)
- A Sorus not white or grayish in color
  - 1 Cysts rounded to spherical
    - a Ripe cysts yellow, reddish-yellow, orange or light red; not brown b. Cysts several or numerous and small.
      - Cysts several or numerous and e Not closely appressed
        - d Slime envelope transparent white or colorless.
          - e Usually 10 to 15 cysts. Itods in cysts, 3 microps long. Cysts 75 to 200 microps
            - 1 Pelyangum ritellinum.

ee. Cysts numerous. Rods 1.3 to 2.0 microns long. Cysts 20 to 80 microns.

5. Polyangium cellulosum.

- 2. Polyangium minus.
- dd. Slime envelope bright yellow.
- 3. Polyangium luteum.
- cc. Closely appressed; often polygonal due to pressure. d. Bright yellow.
  - 4. Polyangium morula. dd. Orange.
- bb. Cysta single, large.

  - c. Large, 250 to 400 microns; reddish-yellow. 6. Polyangium simplex.
  - cc. Smaller, 30 to 60 by 50 to 130 microns; crange to light red. 7. Polyangium ochraceum.
- aa. Ripe cysts reddish-brown to dark brown.
  - b. Cysts lying free, covered by a more or less definite slime envelope. c. About 60 microns in diameter; slime envelope delicate and colorless.
    - 8. Polyangium fuscum.
    - cc. About 35 microns in diameter; slime envelope yellow. 9. Pelyangium aureum
    - bb. Cysts rounded, in stellate arrangements on a slimy substrate.
- 10. Polyangium stellatum.
- 2. Cysts elongate, coiled.
  - a. Cysts brownish-red.

average 36 by 44 microns.

- 11. Polyangium ferrugineum,
- aa. Cysts bright orange-yellow. 12. Polyangium indivisum.
- B. Sorus white or gray in color.
  - 1. Hyaline slime envelope white, foamy in appearance; cysta average 28 by 34 microns. 13. Pelyangium spumosum. 2. Sorus flat, crust-like, smoke-gray in color due to slime en relope; cysts
    - 14. Polyangium fumosum.
- 11. Aquatic, parasitic on Cladophora. 15 Polyangium parasiticum
- Polyangium vitellinum (Link, Mag. d Ges. Naturforschender Freunde zu Berlin, 3, 1809, 42; Myzo-
- bacter aureus Tharter, Bot Gaz . 17. 1892, 403 } Etymology. Modern Latin vitellus,
- like an egg yolk Swarm stage (pseudoplasmodium). When rising to form cysts, milky white Rods large, cylindrical, rounded at either
- end, 0.7 to 0 9 by 4 to 7 microns.
- Fruiting body: Cysts golden yellow, usually relatively spherical, 75 to 150

- microns, accasionally 200 microns in diameter, nimost always surrounded by a white slimy envelope, about 10 to 15 cysts in a mass. Rods in the cysts about 3 microns in length
- Source and habitat : Thaxter (loc. cil.) on very wet wood and bark in swamps. Maine, Belmont. Jahn (1924, loc. cil.) states it is not common; on old wood, lying in moist ditches, also on old poplar bark which was kept moist in a dish, also found twice on rabbit dung.
  - Illustrations: Thaxter (loc. cit.) Pl.

25, Figs. 34-36. Zukal, Ber. d. deutsch Bot Ges., 15, 1897, 512, Pl. 27, Figs. 6-10. Jahn, Kryptogamenflora d Mark Brandenburg, V, Pilze I, Lief 2, 1911, 199, Fig. 3. Jahn, Beiträge zur botanischen Protistologie. 1 Die Polyangiden Geb. Borntraeger, Leipzig, 1921, 77, and Pl. II. Fig. 13

Polyanglum mlnus Krzemieniewski. (Acta Soc. Bot. Poloniae, 4, 1926, 33 )

Etymology Latin minor, less or small. Swarm stage (pseudoplasmodium) Vegetative rods 04 to 06 by 3 to 7 microns.

Trusting bodies: Cyst masses commonly cover the substrate to an area of 0.5 sq mm. Cysts are spherical or oval, small, 20 to 80 by 20 to 50 microns, light rose in color, becoming brownish, embedded in a transparent colorless slime Cyst membrane light colored, relatively thick, 0.5 to 1.0 micron, transparent, revealing the contents. Rods in evat 0.8 to 1 0 by 1.3 to 2 0 microns.

Source and habitat. On rabbit dung sterilized and placed on soil (Poland) Rather rare Relatively slow in appearnnco, only after many days.

Blustrations : Erzemieniewski (foc est ) Pl. IV, Fig. 47-18; Pl. V, Fig. 49

3. Polyanglum luteum Krzemieniewski (Acta Soc Bot. Poloniae, 5, 1927, 98 )

Livrology Latin luicus, saffron- or golden-yellow

Swarm stage (pseudoplasmodium) Not described

Printing bodies Golden yellow, consisting of a few cysts surrounded by a common bright yellow very thick slune wall. The rysts have colories thin walls Rods 07 to 08 by 38 to 58 microns

Source and habitat . Iso'sted from soil on rabbit durg by lirzemieniewski (1927)

Illustration: Krzemieniewski (loc. cit.) Pl. V, Fig. 22, 23.

 Polyanglum morula Jahn. (Kryptogamenflora der Mark Brandenburg., V. Pilze I, 1911, 202.)

Etymology: Modern Latin from Greek mora, mulberry. A diminutive referring to shape of cysts.

Swarm stage (pseudoplasmodium): Not described.

Fruiting bodies: Cysts bright yellow. closely packed into a mulberry-shaped sorus; evsts with thick membrane (3 microns), often made polygonal by pressure, 20 to 35 microns, bound together by slime. The whole sorus is 100 to 200 microns broad Rods in cysts about 3 microns in length. Jahn states he has not atudied fresh cysts. In the older cysts the rods are difficult to observe. Source and habitat: Observed once

only by Jahn (for cit ) on rabbit dung. Blustration: Jahn (1921, loc eit.) 11. 2. Fig 21

5. Polyangium cellulosum imšenecki and Solntreva . (On acrobic cellulose. decomposing bacteria Akademiia Nauk. Leningtad, Isvertiin, 1936, 1115; English summary, 1168)

Etymology: Modern Latin cellulosum. cellulose

Fruiting body, Rods at center of the colony non-motile, forming large orange aggregates Shorter than those at margin. 0.7 to 09 by 34 to 56 microns. Later a concentration of cells occurs. Rods come closer together, form rounded or oval aggregates from which evals become delimited Cysts orange in color, 8 to 21 microns, average 20 to 25 microns. In addition to bacterial cells droplets of fat, 1.5 to 3.5 microns, are sometimes seen within the evat. When treated with IliSO4, cysts are easily broken up under the cover glass. Fruiting lockes are composed of clumps of eysts. Fruiting bother oval or pear-

<sup>\*</sup> Translated from the original by E. V. Prostov, lown State College Library, Ames. lows

shaped, 40 to 55 by 110 to 160 microns, reddish-brown. Covered with a slime membrane (flakes of dried slime). Each composed of 12 to 40 cysts which become polygonal from pressure. No cystophore, except those formed from slimy threads which have a stratified structure. Cysts sometimes arranged in chains.

Spores: 0.7 to 0 8 by 2.2 to 3.5 microns. Vegetative cells: Thick, bent rods, with rounded ends, 0.8 to 1.2 by 3.5 to 8.5 microns. Motile, no flagella. Young tods have 1 chromatin granule, older have 2. Found in cellulese fibers at the margin of the colony. Fibers solidly stuffed near the margin. At the periphery individual cells may be seen.

Vegetative colony: Cysts germinate on filter paper producing vegetative colonies. Colonies large, orange, moist, increasing in size. The older colonies have orange margins while the center is dark brown, corresponding to the color of the fruiting bodies Often show several concentric rings.

Physiology: Rods cover cellulose fibers, partially or completely destroying them. Paper becomes transparent.

Optimum temperature 18° to 22°C A 20° growth very slow.

Grows only on wet cellulose; not in ordinary media. No growth in a hanging drop of broth.

Aerobic.

Source and habitat : Soil.

Illustrations Imsenecki and Solutzeva (loc. cil ) Table II, 2, figures I to 5.

5a Polyangium cellulosun var ferrugineum Mishustin. (Microbiology, Moscow, 7, 1938, 427)

Etymology . Latin ferrugineus, of the

color of iron-rust

Fruting body: Composed of numerous cysts having definite wall Mass of rods has a yellowish tinge, and the cysts are colored reddish-yellow. Color probably confined to the cyst walls Cysts round or egg-shaped, or may be angular due to pressure. Each cyst contains numerous shortened rods Cysts usually 12 to 40

microns in diameter. Numerous cysts grouped into fruiting bodies having bright red or drabbish red color when ripe. Form of fruiting body variable: most commonly rounded, ellipsoidal or biscuitishaped, sometimes sausage-shaped. Cysts confined by an orange-colored slime membrane or envelope. No cystophore present. Fruiting bodies not easily broken up. Vary in size from 80 to 240 microns.

Spores: No data.

Vegetative cells: Long, flexible, nonflagellate cells, motile by crawing, 08 to 1.2 by 3.0 to 5.0 microns. Become shortened and highly refractile during fruiting body formation.

Vegetative colony: On silica gel with cellulose at first pale pink. After six days fruiting bodies of red color appear. together with free cysts and many nonencysted shortened rods. Fruiting bodies numerous at center of colony. and later form in concentric rings around center. Margin of colony composed of vegetative cells; periphery pink. Mature colonies 2 to 5 cm in diameter, bright red, becoming drabbish red; numentation appears to be confined to limited Surface dull, moist. Margin not areas definite.

Physiology: Cellulose at center of colony completely destroyed; not entirely broken down under remainder of colony.

The author considers this a color variant of Polyangium cellulosum Im-

Source: Isolated from the black soils of

Eastern European Russia.

Habitat Digests organic matter in soil.

5b Polyangium cellulosum var. fuscum Mishustin. (Microbiology, Moscow, 7, 1938, 427.)

Etymology: Latin fuscus, dark

swarthy, dusky, tawny.

Fruiting body. Composed of individual cysts, each with separate cyst walf, and beld together by a common slime membrane or envelope. Shortened rodshaped spores inclosed within the cyst

walls. Cjats forming outside the large masses usually rounded; those within often polygonal or angular. Cyats 5 to 21 microns long, oval or egg-shaped Encysted cells give cysts granular appearance. Ripe cysts brown to light brown in color; immature, yellon to pink. Frutting bodies pinkish-yellow when young, beceming brown when ripened. Considerable variation informar round, oval or sausage-shaped, and from 50 to 80 microns up to several hundred microns. Outer shme envelope often indistinct; no dried slime noticeable between the cysts.

Spores: No data

Vegetative cella: Identical with those of Polyangium cellulosum var ferrugineum.

Vegetative colony: A faint yellow east on cellulose-silica gel after 2 to 3 days Becomes yellow-orange to yellow-pink after 6 to 8 days, while center is brownish-gray. Margin pinkish to yellow-pink Surface dull, moist. As fruiting bodies ripen, colony becomes darker, finally dark brown. Reacles diameter of 2 to 5 cm. Fruiting bodies often arranged in form of pigmented, closely set, concentre rings Margin of colony not clearly defined. Usually regularly rounded or oval. Cellulose completely destroyed only at center of colony.

Source. Common in black soils of Sumy Experiment Station. Found only once in rodgol soils

lfabitat : Digests organic matter in soil 5c. Polyangium cellulosum var fulrum

Mishustin, (Microbiology, Moscow, 7, 1938, 427.)

L'tymology: Latin fulrus, reddish-

litymology Latin fulrus, reddishyellow, gold-colored.

Fruiting lody: Rose or pink in color, composed of numerous cysta Young cysta yellow to yellow-orange, becoming pink, rose or red, or pinkish yellow. Cystas men shape anothers of the species; 6 to 21 microns; contain many short rods. Fruiting lodics vary in shape, often

elongated, flagella (?) -shaped (columnar?), up to 20 to 25 by 350 to 450 microns. Also globular, mace-shaped, etc. Usually 25 to 40 by 50 to 80 microns. Cysts unclessed by outer common envelope or alme membrane Tasily broken up mechanically.

Spores. No data.

Vegetative cells: 0.8 to 1.2 by 3 5 to 6 0 microns.

Vegetative colony: On cellulose-cilica gel form a lardly wisible white (colorless?) colony at 2 days. After 6 days becomes pink in color. Fruiting bodies first form near center. After 9 to 10 days central area reddish-pink while periphery has yellowisi east. Mature colony 2.5 to 7.5 cm in diameter, pinkorange color, fairly regularly round or oval in shape. Pigmented concentrie runes of fruiture bodies

Physiology Cellulose entirely destroyed at center of colony and often at other points

Source Podzol soils of Timiriazev

Agricultural Academy. Seldom in black soils of Sumy Experiment Station Habitat. Digests organic matter in

soila.

5d Polyangium cellulosum var luteum

Mishustin (Microbiology Moscow, 7, 1933, 427.)
Etymology: Latin luteus, saffron-yel-

low, orange-) ellow

Fruiting body Poorly organized agglomentions of colories to yellow cysts neboing sporulated cells. Cysts regularly ergalinged to oval, 8 to 20 microns in diameter, predominantly 6 to 10 microns. Matured cysts loosely connected into rounded or elongate muses 40 to 50 by 100 to 150 microns. Hipe fruiting bodies ewily pulled apart.

Spores No data Vegetative cells Similar to others of the species.

Vegetative colony. On cellulose colonies regularly rounded or oval, surface has muist appearance. Vellowish cast 2nd or 3rd day, becoming deeper yellow.

Fruiting body: Colorless sori embedded in hyaline slime forming a common envelope around the cysts Surface white. foamy in appearance; cysts in irregularly rounded accumulations, 100 to 150 microns in diameter. Cysts usually spherical. sometimes elongate; 18 to 38 by 20 to 50 microns; average 28 by 34 microns. Cvst membrane colorless. Cysts contain bundles of shortened cells, a granular colorless mass, and a clear oleaginous fluid.

Spores: Shortened rods.

Vegetative cells: Straight rods, uniformly thick, with rounded ends: 06 to 0.8 by 3.9 to 6.8 microns.

Habitat : Soil.

Illustrations · Krzemieniewski (loc. cit.) Plates XVI-XVII, Figs. 10-13.

14. Polyangium fumosum Krzemieniewski (Acta Soc. Bol. Pol., 7, 1930. 253.)

Etymology Latin fumesus, smoky Fruiting body . A flat, crust-like layer of 2 to 20 (or more) cysts arranged to form a sorus. Sori rounded, up to 90 microns in diameter, or irregularly shaped; often elongate up to 400 microns long Smokygray color due to surrounding slime walls. Outer profile of sheath (or cortex) irregular Cyst wall 2.4 to 35 microns thick: cysts often nearly spherical, 13 to 48 microns in diameter, though frequently elongate. Average 36 by 44

microns. Colorless, single, inclosed in a transparent membrane.

Spores: No data.

Vegetative cells: Long, straight, cylindrical with rounded ends; 0.7 to 03 by 2.7 to 5.7 microns. Encysted cells similar

Habitat : Soil.

Illustrations: Krzemieniewski floc. cit.) Plate XVI, Figs. 6-9.

15. Polyangium parasiticum Geitler. (Arch. f. Protistenkunde, 50, 1921, 67.) Etymology. Latin parasiticus, parasitic.

Swarm stage (pseudoplasmodium): In water, on surface of the alga Cladophora. Pseudoplasmodia small. Rods long, cylindrie, rounded at end and 0.7 by 4 to 7 microns, At first saprophytic, later entering and destroying the Cladophora

Fruiting bodies: Sometimes single, usually 2 to 8 microscopically small, united in irregular masses, spherical or somewhat elongated, From 15 to 50 microns, usually 25 to 40 microns, with hyaline slime. When mature, red-brown in color, with firm wall,

Source and habitat: Found on Cladephora (fracta?) in pool at Vienna (Geitler,

Blustrations: Geitler (1924, loc. cil.) Figs 1-10.

# Genus II. Synangium Jahn.

(Jahn, Beiträge zur botan. Protistologie. I. Die Polyangiden, Geb. Borntraeger, Leipzig, 1924, 79, Apelmocoena Enderlein, Bakterien-Cyclogenie, Berlin, 1924, 243.) Etymology: Greek syn, together and angion, vessel, referring to the clustering of the cysts.

Diagnosis: Cysts provided with an apical point, united more or less completely to resette shaped, hemispherical or spherical fruiting bodies.

The type species is Synangium sessile (Thaxter) Jahn.

# Key to the species of genus Synangium.

Cysts irregular, pointed, united as a resette on a slimy base, without a stalk.

1. Synangium sessile.

 The fused cysts on a simple or branched stalk. A Cyst group spherical, with the points of the cysts covered as with hair, reddish. 2. Synangium lanuginosum.

B. Cyst group an oblate spheroid, yellow. Points of cysts less numerous. 3 Sunangium tharteri.

 Synaagium sessile (Thayter) Jahn (Chondromuces sessilis Tharter, Bot. Gaz., 57, 1904, 411; Jahn, Beiträge zur botanischen Protistologie I. Die Polyangiden, Geb. Borntraeger, Leipzig, 1924, 79)

Etymology: Latin sessilis, sessile, not stalked.

Swarm stage (pseudoplasmodium); Not described.

Fruiting body: Cysts form on the base a clump or rosette without trace of stalk. Diameter of rosettes 100 to 250 microns Individually the cysts are quite variable in form, irregularly spindle-shaped, usually short-pointed, wrinkled surface toward the tip. At the base they fuse or unite to irregular masses. Cysts 18 to 55 by 25 to 75 microns, average 40 by 50 micross.

Source and habitat: Tharter (loc. cit ) found this on decaying wood in Florida Illustration . Tharter (loc cit.) Pl 27,

Figs. 14-15

2. Synangium lanuglacsum (Kofler) · Jahn. (Chondromyces lanuginosus Kofler, Sitzber, d. Kais, Akad, Wiss Wico. Math.-Nat. Klasse, 122 Abt , 1913, 861; Jahn, Beiträge zur botanischen Protistologie. I. Polyangiden, Geb. Borntracger, Leinzig, 1921, 79 )

Etymology: Latin languinesus, woolly Swarm stage (pseudoplasmodium): Not described

Fruiting body . Cyst cluster, consisting of united cysts, spherical or oval, 80 to 200 microns in diameter, when dry, dark flesh-colored, covered with hairs 15 to 50 microns long, originating from the individual cysts and giving the cyst cluster the appearance of a hairy ball Skin of the eysts not definite. Rods within the cysts 3 to 6 microns The cyst clusters are terminal on more or less forked stalks. about 1 mm high

Source and habitat: Kofler (loc. cit.) found this on rabbit dung at Vienna.

Illustrations Kofler (loc. cit.) Pl 1, Figs. 1-3

3 Synanglum thaxterl (Faull) Jahn. (Chondromyces thanter, Faull, Bot. Gaz., 62, 1916, 226; Jahn, Beiträge zur botanischen Protistologie, I Die Polyangiden Geb Borntraeger, Leipzig, 1921, 79 ) Regarded as a synonym of Synangium lanuginosum by Krzemieniewski, Acta Soc. Bot. Polonine, 4, 1926, 39.

Etymology. Named for Dr. Roland Tharter, American botanist

Swarm stage (pseudoplasmodium): Cultured for 2 years on dung, best in mixed cultures Rods 0.5 by 3 to 0 microns.

Fruiting body : Fruit cluster flattened. spherical, yellow to flesh color or reddish-orange, with a stalk which varys in length, about 140 microns is diameter. The bristles corresponding to the single eyets are 15 to 30 mierons long, at the base 10 to 12 microns wide Sometimes evet single, usually 3 to 1, occasionally 20 to 30 Rods 0.5 by 3 to 6 microns Stalk maximum length 0.75 mm, usually 350 microns, single or branched. Broad based, parrowing to aper and yellow in color. In rermination rods move from basal scar of membrane, leaving the empty sack behind

Source and habitat. On deer dung in Ontario, Canada (Faull)

Illustrations Fault (for cit ) Pl. 5 and 6 Jahn (loc cit ) Fig. X, p. 80,

## Genus III. Melittapptum Jahn.

(Jahn, Beiträge zur botan. Protistologie. 1. Die Polyangiden, Geb Borntraeger. Leipzig, 1921, 78 )

Etymology: Greek melitta, bee and angion, westel, because of the boney-comb pattern of the membrane.

Diagnosis: Cysts brownish orange-red, on short white stalk, like a mushroom. Has appearance of a white-stalked Boletus. The rods inside stand at right angles to the membrane. Upon germination the covering membrane is left colorless and with an appearance of honey-comb.

The type species is Melittangium boletus Jahn.

1. Mellttangium boletus Jahn. (Beitrage zur botanischen Protistologie. I. Die Polyangiden, Geb. Borntraerer. Leipzig, 1924, 78.)

Etymology. Latin boletus, a kind of musliman.

Swarm stage (pseudoplasmodium): No description

Fruiting bodies: Cyst stalked, mushroom-like, white when immature, then yellowish-flesh colored, finally yellowishbrown to nut brown, when dried more reddish-brown. Larger diameter of evst about 100 microns, height 40 to 50 microns. length of white stalk about 40 microns. length of rods in the cyst 3 to 4 microns by 0.5 microns. Sometimes the cyst is smaller and spherical (50 to 60 microns diameter), sometimes there is fusion of neighboring cysts, occasionally the stalk is obortive.

Source and habitat: Jahn (loc. eil) found this not uncommon on rabbit and deer dung in the vicinity of Berlin, also on deer dung from Denmark. Krzemienienski (1927, loc. cit.) reported it as common in Polish soils.

Hlustrations: Jahn (loc. cil.), Pl. 2, Fig. 17 and 18. Also Fig B, p. 11, C-F, p. 23, O-Q, p. 43, T-U,p. 55. Erzemieniewski, Acta Soc. Bot. Polonise, 4, 1926, 1, Pl. V, Fig. 55-56.

### Genus IV. Podanglum John.

(Cystobacter Schroeter, in Cohn, Kryptogamenstora v. Schlesien, 5, 1, 1886, 170; Jahn, Beitruge zur botan Protistologie. I. Die Polyangiden. Geb. Borntraeger, Leipzig, 1924, 80, Monocystia Enderlein, Bakterien-Cyclogenie, Berlin, 1924, 243)

Etymology. Greek pus, podis, foot and angion, vessel.

Diagnosis. Cysts chestnut-brown or red-brown, single on a more or less definite white stalk

The type species is Podangium erectum (Schroeter) Jahn.

## Key to the species of genus Podanglum.

I. Stalk scarcely definite, cysts short, appressed, if elongate then passing over from the white stem into the club-shaped cyst Ripe cysts chestnut-brown.

1 Podangium erectum.

II. Stalk well differentiated

A Cysts apherical, often arregular, confluent, the white stalk short. 2. Podangium lichenicolum.

B. Cysts lengthened ellipsoidal, red-brown, definitely differentiated from the white, slender stalks

3. Podangium gracilipes.

1. Podangium erectum (Schroeter) Jahn. (Cystobacter erectus Schroeter, in Cohn, Krytogamenflora v Schlesien, S. 1, 1886, 170; Chandromyces erectus Thaxter, Bot Gaz , 23, 1897, 407, Jahn, Besträge

zur botamschen Protistologie. I. Die Polyangiden, Geb. Borntraeger, Leipzig,

Etymology Latin ereclus, erect, upright

Swarm stage (pseudoplasroodium) Kofler states rods are 2 to 5 microns in length.

Truiting bodies. Cysts usually short, cumded above, orange-red changing to chestnut-brown, single on a white to yellow hypothallus constituted from the slime remaining behind. A definite "foot" of whitsh slime is seldom observed. Fifty to hundreds together Usually about 80 microns high and 40 to 50 nuerons broad above, smaller below, often spheread cysts 60 microns in diameter Rods in cysts 60 by 4 microns.

Jahn helieves the European form to be distinct from that described by Thaxter Thaxter's form produces eystophores to 300 microns long which wither at maturity so that cysts appear sessile

Source and habitat. Thaxter (doc cit ), horse dung in laboratory cultures, Massachusetts, Kofler (Sixtber, d. Knas Akad Wiss, Wien, Math. Nat. Klasse, 122 Abt., 1013), mouse dung. Jahn (1024) common on manure of different kinds, also on bark covered with lichens. Krzemennewski (Acta Soc. Bot. Pol., 5, 1927, 102) reported this species from Polish coil, but rare.

Illustrations Thavter (toc cit) Pl 31, Figs. I6-19. Quell, Cent. f Bakt, II Abt., 16, 1903, Pl. 1, Figs. 4 Jahn (toc. cit.) Pl. 1, Figs. 7, 8, and 9 Krzemieniewski, Acta Soc Bot Polonice, 4, 1926, 1, Pl. V, Figs. 52-53

 Podangium lichenicolum (Thavier) Jahn (Chondromyces lichenicolus Throxter, Bot. Gaz. 17, 1892, 402; Jahn, Beiträge zur botanischen Protistologie.
 Die Polyangiden, Geb Borntracker, Leipzig, 1921, 81.)

Ltymology: Greek lichen, tree moza, lichen. Latin -colus, dwelling.

Swarm stage: Heddish, rods cylindrical, tapering slightly, 06 by 5 to 7

microns. Germinate readily after drying for 18 months when sown on rootst lichens

Fruiting bodies. Cysts single, rounded or irregularly lobed, often confluent. Cystophore short, squarish, often lacking or misshapen Cysts 28 to 35 microns, stem 7 to 8 by 10 microns.

Source and habitat: Thayter (1892), parasite upon living lichens, which it destroys, New Haven, Conn Thayter (1901, loc att), lichens, Indiana, on algae, seen on wet boards, in mill race, Massachusetts.

Hustrations Thaxter (1892, loc. cit ) Pl. 23, Figs 20 to 23 Quelil, Cent. f. Bakt , II Abt , 16, 1906, 9, Pl 1, Fig 6.

3 Podangium gracilipes (Thavter) Jahn (Chondrowyces gracilipes Thavter, Bot Gaz, 23, 1807, 100; Jahn, Beiträge zur botanischen Protistologie. I. Die Polyangiden, Geb Borntraeger, Leipzig, 1921, 82)

Etymology Latin gracilizes, slender footed

Swarm stago Rods 5 to 7 microns.

Fruiting bodies. Cysts bright orangered, or red, 25 by 35 merons, elongate, rounded, on a white pointed stalk, right and persistent on substratum, rods also in stalk. Shortened rods in cyst 3 to 5 microns. Cysts sometimes pear-shaped, codurous.

Source and Indust Theater (loc cit.), from rablat dung, Mwacabaceta Kofter (1913, loc cit.), dung, Vienna Jahn (loc cit.) relatively common. Twice on rablat dung new Berlin, once on goot dung in Norway. Krzemieniewski (1927loc cit.) reported this species from Polishsol, but rare.

Illustrations Theater (foc. cit.) Pl. 31, Figs. 20-21. Quebl, Cent. ft. Bakt., Jf. Abt., 16, 1996, Pl. 1, Fig. 12. Jahn (foc. cit.) Pl. 11, Figs. 19, 20. Krzemieniewski (1926, foc. cit.), Pl. V, Fig. 51.

# Genus V. Chondromyces Berkeley and Curtis.

(See Berkeley, Introduction to Cryptogamie Botany, London, 1857, 313; Stigmatella Berkeley and Curtis, ibid. 1857, 313 (figure but no description); Berkeley (description), Notes on North American Fungi, Grevillea, 3, 1874, 97; see Berkeley and Curtis, in Saccardo, Sylloge Fungorum, 4, 1886, 679, Polycephalum? Kalchbrenner and Cooke, Grevillea, 9, 1890, 22; Myzobotyrs Zukal, Ber. d. deutsch. Bot. Gesellsch., 14. 1896, 316; Cystodesmia Enderlein, Bakterien-Cyclogenie, Berlin, 1924, 243.)

Synonymy: A species was figured and named in 1857 by Berkeley as Chondromyces crocatus Berkeley and Curtis, but not described. The generic name was finally described in 1874. Probably the date of the name should be the date of its description, although it is possible that an adequate labeled illustration should be interpreted as

valid publication.

Etymology: Greek chandros, grain and myces, (fungus).

Diagnosis: Cysts compactly grouped at the end of a colored stalk (cystophore). Cystophore simple or branched.

The type species is Chondromyees crocalus Berkeley and Curtis.

## Key to the species of genus Chondromyces.

I. Cysts not in chains.

A. Cysts sessile when ripe.

1. Cysts not pointed.

a. Cysts rounded. b. Yellow.

1. Chondromyces crocalus.

bb. Bright orange-red.

2. Chondromuces aurantiacus. 3. Chandromyces cylindricus.

2. Cysts pointed.

4. Chondromyces apiculatus.

az. Cysts cylindrical.

B. Cysts borne on stalk or stipe when ripe. 1. Cysts orange-colored and truncate or rounded at distal end.

a. Cystophore usually simple.

5. Chondromyces pediculatus.

aa. Cystophore usually branched.

6. Chondromyces medius. 2 Cysts copper-red when rape; pear-shaped.

7. Chondromyces minor.

II. Cysts in chains at end of a compact stalk.

S. Chondromyces catenulatus.

1. Chondromyces crocatus Berkeley and Curtis. (Berkeley, Introduction to Cryptogamic Botany, London, 1857, 313; Berkeley, Notes on North American Fungi, Grevillen, 5, 1874, 64, Myzobotyrs variabilis Zukal, Ber. d. deutsch. bot Ges., 15, 1896, 340, according to Krzemieniewski, Acta Soc Bot Poloniae, 4, 1926, 33.)

Etymology: Latin erocatus, saffron vellow.

Swarm stage (pseudoplasmodium): Pale orange-red. Rods cylindrical or tapering slightly, straight or slightly curved, 0.6 to 0.7 by 25 to 6 microns. Cultivated on nutrient agar and sterilized horse dung. Cysts placed in moist chamber germinate in one or two days.

The contents are first contracted within the cyst walls, showing the individual rods. The cyst wall is then absorbed or disappears at the base, and the rods escape in a regular stream until only the empty eyst is left.

Fruiting bodies: Cysts nearly conceal, rounded at tip, average 12 by 28 merons (6 to 20 by 15 to 45 merons), straw yellow, in spherical heads of variable numbers (70 to 90 merons) at tips of branches. Cystophore orange-colored, slender, striated, often twasted or urregularly bent, simple or branched as many as 5 times. About 600 merons high, rarely 1 mm.

Source and habitat: Thanter (1892, loc. cit.), melon rind from South Carolma and old straw from Ceylon and Cambridge, Mass. Zukal (loc. cit.), Vienna Quedi, dung from Java and on derdung, near Berlin. Thanter (1901. loc. cit.), New Haven, Conn., Tabor, Iowa, Florda, Laubach, Java.

Illustrations: Herkeley, Introduction to Cryptogamic Botany, London, 1857, 313 Thacter, Bot Gaz, 77, 1892, 389, Pl 22 and 23, Figs. 1-11 Quehl, Cent f Bakt., II Abt., 16, 1906, 9, Pl 1, Fig 10 Jahn, Kryptogamenflora der Mark Brandenburg, V. Pilze I, Lacf 2, 1911, 199, Fig. 6 Jahn, Betträge zur botanschen Protistologie, 1. Die Polyangsden, Geb Borntraccer, Lespzig, 1923, Pl 2, Figs 11, 15, and 18, 15

2. Chondromyces aurantiacus (Berkeley and Curtis) Tharter (Stigmatella aurantiaca Berkeley and Curtis (nn description), Introduction to Crypto game Batany, London, 1857, 313, Berke by (description), Notes on North American l'ungi, Grevillea, 3, 1874, 97, Stilbum thylidesporum Berkeles and Browne, 1873, 96, see Saccardo, Salluge Fungorum, 4, 1896, 571, Polycephalum aurantiacum Kalchbrenner and Cooke, Australian Fungs, Grevilles, 9, 1500, 23, Myzolotrys variabilis Zukal. deutsch, Bot. Ges., 14, 1896, 340, Chondromyces aurantiacus Jahn, Kryptogamenflora der Mark Brandenburg, V, Pilze I, 1911, 206)

Elymology Modern Latin aurantiacus, orange-colored

Swann stage (pseudoplasmodum) Flesh-eolored, distinctly reddish Rods large, tapering somewhal, normally straight, rounded at either extremity, 06 to 1 by 7 to 15 microns, average 05 by 7 microns (2) Lasily cultivated on nutrient agar, but on this rarely produces well formed cystophores, though cultivable on its ordinary substrate without difficulty

Fruiting bodies: Cysta oval, elliptical or spherical, average 30 by 50 micross, at first stalked then sessile, united in small numbers at once and of cystoplucae, bright orange-red, electaut-brann when kept moust for a considerable period or feeb-colored. Cystoplune colories, often yellowish at the tip, usually simple, rarely forked, 200 to 400 micross light

The Krzemieniesskis (Acta Soc Bot Polonice, 6, 1927, 96) have described a Chondromyce auranticaus var fruitevera in which the fruiting body consists of a greenish, later yellowish mass of road which develops into a thick cystophore with numerous terminal cysts. The cysts are awal or spherical, sometimes autherose-structions, first orange-solored, letter hums, about 40 to 120 by 30 to 90 nicrons. The cyst rods are 0.9 to 1.0 by 23 to 3.1 microns.

Source and habital Berkeley (ISS7, for cit), in briken Berkeley and Brown (ISS3, for cit), in rotten wood Iron (eylon Thaver (ISS2, for cit)) in North America rot uncommon ou old wood and fung. Zakal (for cit), Vienna Thixter, Bot Gaz, 25, 1857, 375, on antelope dueg from Africa. Thaxter, Bot Gaz, 37, 1901, 465, Horda, Albutppines Quelli, Cent. (Hakt., It Hakt., It Hawas (Left), dueg from Java Kiremenuswik, Acta Soe Bot. Poloniae, 4, 1926. I., rare in Polish soil.

Hustrations Berkeley and Brown

(1873, loc. cit.) Pl. 4, Fig. 16. Kalehbrenner and Cooke (loc. cit.). Thaxter (1892, loc. cit.) Pl. 23 and 24, Figs. 12-19 and 25-28. Zukal (loc. cit.) Pl. 20. Quebl (loc. cit.) Pl. 1, Fig. 10. Jahn, Beiträge zur botanischen Protistologie, I. Die Polyangiden, Geb. Borntraeger, Leipzig, 1924, Fig. V, p. 57, Fig. W, p. 59. Krzemieniewski (1926, loc. cit.), Pl. V, Figs. 57-60, (1927) var. frutescens Pl. VI. Figs. 27-35

3. Chondromyces cylindricus Krzemieniewski. (Acta Soc. Bot. Pol., 7, 1939, 260.)

Etymology: Greek kylindrikos, cylindrical.

This organism was at first thought to be a variety of Chondromyces aurantiacus. It is separated from it on the basis af size, shape and pigmontation of the cysts.

Fruiting body: Cystophore composed of bundles of cells, develops from n thick, greenish-yellow mass of rods; unbranched or with short hranches, colorless to pale orange-yellow; up to 200 microns high. Numerous cysts develop from cystophore and branches; at first borne on slender stipe 20 microns long, later becoming assale on cystophore. Young cysts orange-yellow, later hecoming deeper orange, and finally bright orange-hrown when ripe Shape variable: oval, irregularly rounded; predominantly cylindrical with rounded ends, 16 to 49 by 30 to 90 microns; average 29 by 55 microns.

Spores: Shortened rods 0.8 to 1.1 hy 18 to 33 microns.

Vegetative cells: Long rods, tapered at ends, 0 5 to 0.6 by 6.7 to 11.0 microns. Habitat - Soils

Illustrations. Krzemieniewski (loc. cit.) Plate XVII, Fig. 18

4 Chondromyces apiculatus Thaxter. (Bot. Gaz , 23, 1897, 405.)

Etymology Modern Latin from Latin apex, a point with a small point. Swarm stage (pseudoplasmodium).

Rods 1 by 3 to 20 microns Does not

grow as well on nutrient agar as Chondromyces crocatus and produces cysts and cystophores rarely. Cultivated on dung. Kofler states rods are 3 to 5 microns in length.

Fruiting bodies: Cysts of variable form, cylindrical to broadly turnip-shaped, usually with hasal and apical appendages, the latter longer and pointed, bright omnge, 28 by 36 microns. Cysts united in a single spherical terminal head, about 200 microns in diameter. Cystophore rigid, stiff, seldom hranched, to 1 nm high, colorless, longitudinally striate. Cysts germinate at both base and aper.

Source and habitat: Thavter (1897, loc. cit.), on antelope dung from Africa. Thanter (1904, loc. cit.), deer dung, Philippines, Florida. Baur (1905, loc cit.), on rabbit dung near Berlin. Kofler (1913, loc cit.), on rabbit dung near Vienna

Hlustrations: Thaxter (1897, loc. cit.)
Pl. 30, Figs 1 to 15. Quehi (1995, loc. cit.), Pl. 1, Figs 13 to 14. Jahn (1911, loc. cit.) p. 199, Fig. 5.

5. Chondromyces pediculatus Thaxter. (Bot. Gaz., 57, 1904, 410.)

Etymology: From Latin pediculus, a small foot; small footed (stalked). Swarm stage (pseudoniasmodium):

Rods 0 6 to 0 7 by 2 to 4 merons. Fruiting bodies: Cysts tounded to bell-shaped, truncate at distal end, orange-yellow, when dry orange-red, 55 to 50 microns. Sessile on stalks 40 to 60 microns in length, which are arranged as an umbel on the tip of the cystophore 300 to 700 microns in length, solitary, simple, usually rather slender and somewhat wrinkled.

Source and habitat: Thaxter (loc. cit ), on goose dung in South Carolina.

Hiustrations: Tharter (loc cit.) Pl. 26, Figs. 7 to 13.

 Chondromyces medius Krzemicaiewski. (Acta Soc. Bot. Pol., 7, 1930, 263.) Etymology Latin medius, roedial, moderate.

Fruiting body: Glistening, orange-colored cysts attached to extonbore in clusters by means of filamentous stipes about 40 microns long. Decaulous. Mass of rod-shaped cells from which cystophore develops colorless to pink. Cystophore composed of bundles of cells, often branched; appear similar to those of Chondronyces aurantiaeus van fruter-cens Cysts variable in shape; predominant are those rounded or flattened at the apex and tapered toward the base, 21 to 78 by 20 to 93 microns. Average 51 by 55 microns.

Spores: No data,

Habitat Soil, Hlustrations: Krzemieniewski (loc. est.) Plate XVII, Figs. 20-22

7 Chondromyces minor Krremieniewski (Veta Sor. Bot. Pol., 7, 1930, 265) Litymology. Latin minor, less, little, small.

I ruiting lody: Cell masses from which eyatophoro develops, reddish-violet in color Cystophore white, simple or branched, up to 120 microns high, 17 to 59 microns thick. Cysta borne in elumps of 2 to 20 at aprev of cystophore and branches on deleast colories stipes Cysta mee red becoming copper-red when dry, pear-shaped, tapering toward base and browl at the aprex; 20 to 47 by 20 to

65 microns; average 28 by 38 microns. Deciduous. Stipes 3 to 6 by 10 to 25 microns.

Spores: 0 6 to 0.8 by 2.9 to 4.3 microns. Vegetative cells: 0 6 by 3 8 to 7.2 micross.

Habitat: Soil.

Illustrations: Krzemieniewski (loc. cut.) Plate XVII, Figs 23-24.

8. Chondromyces estenulatus Tharter. (Bot. Gaz., 57, 1901, 410 )

Etymology Modern Latin from catena, a chain, = occurring in chains.

Swarm stage (pseudoplasmodium): Cultivated only on original substrate, Rods i to 1.3 by 4 to 6 microns.

Fruiting bodies: Cysts light y clloworange, 20 to 50 by 15 microns in rosarylike chains, which may be branched once or twice, seesile on a short compute stalk, cysts separated by shirveled isthmuses Chains to 300 microns, Cystophore simple 150 to 300 microns, eleft above, and passing over into the chains, rather broad at bave and spreading somewhat on substratum. The divisions of the cystophore are pointed, short and slightly swollers.

Source and habitat 'Thaxter (loc. cit.), on decaying poplar wood, New Hampshire

Illustrations: Thaxter (loc. cit.) Pl. 26, Figs 1 to 5.

## FAMILY V. MYXOCOCCACEAE JAHN.

(Beitrage zur botan. Protistologie I. Die Polyangiden, Geb. Borntraeger, Leipzig, 1924, 84.)

Diagnosis: The rods become shortened when fruiting occurs (resting cells are formed), and develop into spherical or ellipsoidal spores or microcysts. Upon germination the vegetative cell develops from the spore by a process analogous to budding, pinching off at the point of emergence, leaving the spore wall entirely empty. In three of the genera, definite fruiting bodies are produced. In Sporocytophaga, the spores (microcysts) are produced from the vegetative cells without development of fruiting bodies.

#### Key to the genera of family Myxococcaceae.

I. Definite fruiting bodies formed.

A. Fruiting body not containing or made up of cysts.

Fruiting bodies deliquescent.

Genus 1. Myzococcus, p. 1040. 2. Fruiting bodies firm, not deliquescent.

Genus II. Chondrococcus, p. 1044.

B. Fruiting body made up of cysts.

Genus III. Angiococcus, p. 1047.

II No definite fruiting bodies formed.
Geous IV. Sporocytophaga, p. 1048

## Genua 1. Myxococcus Thazter.

(Bot. Gaz., 17, 1892, 403.)

Etymology: Greek myza, mueus and kokkos, berry; slime sphere.
Diagnosis: Spherical spores in conical or spherical or occasionally ovoid upright fruiting bodies, united by a loose more or less mobile slime.

The type species is Myzococcus fulous (Cohn emend. Schroeter) Jahn.

## Key to the species of genus Myxococcus.

I Stalk lacking or indicated only by a constriction.

A. Spores average less than 14 microns in diameter

1. Fruiting body ted or brownish-flesh color.

1. Muzocorcus fulvus.

1. Myzocorcus Ju 2. Fruiting body light blood-red

2. Myrococcus cruentus.

B. Spores average 2.0 microns io diameter.

1. Fruiting body yellow to greenish-yellow.
3. Muzacoccus virescens.

2. Fruiting body yellow-orange to orange.

4. Myzococcus zanthus.

Well developed stalk supporting spherical spore mass above.

A Spores spherical.

5. Myzococcus stipitatus.

B. Spores oval.

6. Myzococcus ovalisporus.

1. Myrococcus fulvus (Cohn emend. Schroeter) Jahn. (Micrococcus fulcus Cohn?, Beitrage z Biologie d. Pflanzen, t. Heft 3, 1875, 181; Jahn (1924) states that the description of Cohn is too inadequate to determine whether he was dealing with a true species of the genus Muzococcus. Cohn described the organism from horse dung, as producing conical, rust-red droplets I mm in diameter, the cells bound together by an intercellular slime, cells large, 1.5 microns in diameter. Micrococcus fulrus Schroeter, Schrzomycetes, in Cohn, Kryptogamenflora v. Schlesien, 3, 1, 1886, 141. Observed on horse dung and rabbit dung at various localities Jahn insists that this organism must be the same as Murococcus rubescens Tharter. Murococcus rubescens Thanter, Bot, Gaz . 17. 1892, 403, Myrococcus ruber Baur, Arch. [ Protistenkunde, 5, 1903, 93, Myrococcus pyriformis A. L. Smith, Jour Bot , 39, 1901, 71; Myzococcus garanensis de Kruy ff, Cent. f. Bakt, H Abt , 21, 1908, 356. Hhodococcus fulrus Winslow and Winslow, Systematic Relationships of the Corencese, 1908, 262; Muzococcus fulius Jahn, Beiträge zur botanischen Protestologie, I. Die Polyangiden, Geb Borntracger, Leipzig, 1924, 81)

Litymology Latin fulrus, reddishyellow.

Swarm stage (pseudoplasmodum). Thanter states that the risk masses are reddish, rolls slender, arregularly curved, 0 t by 3 to 7 microns. Bauer followed strice germanation in banging drop Spores 0 S to 1.3 microns, without strue ture, in five bours swollen to I to 1.5 microns, and no lorger as refractive The merchane is not burst; the cell becomes orgabaped, then clongate and extradric. He regards has Muzococcus enter as distinct from Theater's Mazzcoccus subsected in part because of there. ences in space germination. The cells Lea we notice after dealing or trebling in leigth. It is a creeping motion in motort with the substrate; the cells do not "swim." Rate of motion 5 to 10 microns per minute. Rods eventually are 0.5 to 0.7 microns by 4 to 10 nicrons. Cell division by transverse fission. Spore formation is through shortening and rounding of the cells, the converse of germanation. In hanging drop the cells tend to congregate after three days and to transform into spores. Rods sporulate in 3 to 1 hours. The rods continue to congregate, and the spore mass increases, held together by viscous matrix. Verestative cells are licht fields color.

Vegetative cells are light fieth color.

Gelatin is quickly liquefied, completely in 1 to 2 days, but no fruiting bodies are formed.

Kofler secured good growth on Hasting's milk agar, and determined digestion of casein.

Bair could not recure good growth on any agar medium of krown composition. With peptone, sugars, etc., rome growth but not normal when peptone present. He carried one strain 3) months on peptone sugar agar. Good growth on dung agar. Addition of peptone to dung agar not significant in effect, the addition of glucose altered the form of the fruiting bodies.

De Krusff secured best results with a dung extract agar to which was added ammonium nitrate and potassium phosphate.

Fruiting bodies; Spherical or clongate pear-shape, constitiet below, often with definite slimy stalk, feels red to brown sub-red, when dry rust-red to brown about 300 microus in dameter. Spores 1 to 12 microus John (1921, loc cit.) notes two varieties.

var albur (Latin albus, white). Constantly white, even when transferred. Fruiting bothersomewhat smaller than the type.

var. ministus. (Latin ministus, painted with red lead or cinnabar.) Color cinnabar-red, fruiting leabes son cubat larger.

The firm described by de Kruyff had spores 16 n icrons in done etcr.

Source and habitat: Thaxter (1892, loc. cit.), on various decaying substances, lichens, paper, dung, cte. Smith [loc. cit.), on rabbit dung from Wales. Baur (loc. cit.), on cow and dog dung. De Kruyff (loc. cit.), on stable manure in Java. Jahn (1924, loc. cit.), very common, on almost all specimens of dung, also on bark, decaying wood, and lichens. Krzemieniewski (1927, loc. cit.) very common in Polish soil. Kofler (loc. cit.), dung of rabbit, horse, goat, mouse, roe, deer, on stem of clematis and decaying leaves and in bird nest.

Illustrations: Cohn (loc. cit.) Pl. 6, Fig. 18. Smith (loc. cit.) Fig. 1. Baur (loc. cit.) Figs. 1, 2, 3, and Pl. 4, Figs. 1-13, 16. Jahn (1921, loc. cit.) Figs. 1-M, p 43, Fig. R, p. 47. Krzemieniewski, Acta Soc Bot. Poloniac, 4, 1920, Pl. 1, Figs. 7-8. Kofler, Sitzber. d Kais. Akad. Wiss. Wien. Math.-Nat. Klasse, 122 Abt., 1913, 845, Pl. 2, Figs. 10 and 12.

Cultures: Baur (loc. cil.) states that be deposited a pure culture in the Zentralatelle fur Pilzkulturen.

Myxococcus cruentus Thaxter.
 (Thaxter, Bot. Gaz., 23, 1897, 395;
 Chondrococcus cruentus Krzemieniewski,
 Acta Soc. Bot. Polomae, δ, 1927, 79.)

Etymology: Latin cruentus, blood-red. Swarm stage (pseudoplasmodium): Rods 0.8 by 3 to 8 microns Was not cultivated.

Fruiting body: Cysts regularly spherieal, 90 to 125 microns, blood-red. Stime forms on the surface a more or less definite membrane, in which the spores lie Spores oval or irregularly oblong about 09 to 1 by 12 to 14 microns. Cysts are densely aggregated.

Source and habitat: Thaxter (loc. cit.), on cow dung, Tennessee. Krzemieniewski (1927, loc. cit.) rare in Polish soils.

Illustrations Thaxter (loc. cst.) Pl 31, Figs. 28-29. 3. Myzococcus virestens Thaxter. (Bot. Gaz., 17, 1892, 404.)

Etymology: Latin virescens, becoming green.

Suarm stage (pseudoplasmodium): Rod masses greenish-yellow. Rods slender, irregularly curved, 0.4 by 3 to 7 microns. When cultivated in potato agar tends to lose its green color and becomes yellowish. Badian (1930) reports the presence of a dumb-bell-shaped nuclear structure which splits longitudinally in cell division, and shows autogamy preceding and a reduction division during spore formation.

Fruiting body: Spherical or conical, usually less rounded than other species of the genus, yellowish, occasionally greenish, in culture on artificial media, easily becoming white, 150 to 500 microns. The alime deliquesces in continued moisture. Spores large, about 2 microns.

Source and habitat: Thaxter (loc. cit.), on hen's and dog's dung, New England, Jahn (1924, loc. cit.), not very abundant on dung of rabbit, horse, stag and black cock. Krzemieniewski (1927, loc. cit.), common in soil in Poland. Badian (loc. cit.), Poland.

Hustrations: Krzemieniewski, Acta Soc. Bot. Poloniae, 4, 1926, Pl. I, Fig. 9. Badian, Acta Soc. Bot. Poloniae, 7, 1930, 55, Pl. 1, 8 figures.

4. Myxococcus xanthus Beebe. (Jour. Bact., 42, 1941, 193.)

Etymology: Greek zanthos, orange, golden.

Fruiting body: Spherical to subspherical, usually sessile but occasionally constricted at the base giving the appearance of a short stalk or foot. Mature fruiting body up to 300 to 400 microns in diameter, often slightly flattened on top or one site Olor varies from light yellowish-orange when young to bright orange when mature; color constant, never tending to and greenish-yellow. No outer cyst wall or limiting membrane discernible, the spores being imbedded in the slime holding the mass together. Usually single, though two or three fruiting bodies may become joined to form an irregular mass; each is attached to the substrate, however, and never bud one from another.

Spores. Spherical, with thick outer wall or membrane. Highly refractile. Stain very easily with any of the ordinary bacterial or nuclear dyes 20 microns in diameter, seldom larger.

Vegetative cells : Large, flevible, single, Grain-negative rods with rounded ends. No flagella, but move on surface of soid or semi-solid substrate with a craxling or creeping motion. Vary in size from 0.5 to 10 by 4 to 10 microns, average 0.75 by 5 microns. More or less distinct cell will offer evident.

Vegetative colony: Characteristics

On plain 1.5 per cent agar (no nutrients added): Very thin and transparent, often hardly visible except by transmitted light. Little or no purmentation. Surface covered with line, more or less regularly spaced rulges causing a dull macro-copic appearance without gloss or sheen. Margin very thin and quute regular.

On rubbit dung decoction agar Colony thicker, the surface being booken by Vens or ridges radiating from the center. Thick central area oftensmooth and glossy while margin much the sume as that on plain agar. Vens or ridges extend outward from center in loses pural, always in clock-uise direction. Pigmentation, yellon to pale orange, confined to thicker central portion, extends part way along veins to margin extends part way along veins to margin.

On nutrient rgar-Growth poor Colony thick, at first heavily veined, the sense later merging to form an irregular glossy surface. Colony remains small, jugmentation usually fairly heavy, reargin thick, irregular to lobate

Physiology: Grows well on mineral

salt-agar to which has been added dulcitol, inuln, cellulose, reprecipitated cellulose or starch; hydrolyzes starch; does not destroy cellulose to any appreciable extent. Best growth on suspension of killed bacterial cells in gar; suspended cells in growth area lysed. Development completely unbiblied by arabinose, larely by maltace and mannose.

Source: Isolated from dried cow dung, Ames, Iona.

Habitat Decomposed bacterial cells in dung.

Illustrations · Beebe (loc. cit.) Figs. 1-28

5 Myxococcus stipitatus Tharter. (Bot. Gaz , 23, 1897, 395)

Etymology, From Latin slipes, stalk; stalked

Swarm stage (pseudoplasmodium): Itods 0.5 to 0.7 by 2 to 7 microns or longer. Grows well on nutrient agar, but does not fruit readily

Fruting lody: Spore mass nearly spherical, 175 microns in drameter, deliquescent, sessile on a well developed compact stalk, white to yellowish and fisch color. Spores 0.8 to 1.2 by 10 to 115 microns. Stalk 100 to 200 microns long, 30 to 50 microns wide.

Source and habitat Thavter (los. cit.), repeatedly on dung in laboratory cultures at Cambridge, Muss., Maine, Tennessee Krzemieniewski (1927, los. cit.), common in Polish soils.

Hlustrations, Tharter (loc. cit.) Pl. 31, Figs. 30 to 33, Krzemiemenski, Acta Soc. Bot. Polonise, 4, 1926, Pl. II, Figs. 13-14.

6 Myzototeus ovalisporus Krzemieniewski (Acta Soc Bot , Pol , 4, 1926, 15.) Etymology Modern Latin orolis, oval, Greek sporus, seed Oval spored.

Swarm stage (pseud-plasmodum); Not described.

Fruiting leaders Produces alread apherical, characteristically abortened, usoid spore masses of light milky yellow color. These are often raised on a poorly developed stalk. This stalk always shows some bacterial cells remaining, and in this and rolor is differentiated from M. stipitatus. From the base of the stalk or directly from the substrate one or more small fruiting bodies develop. Spores are oval, sometimes irregularly spherical, 1.3 to 1.0 by 1.0 to 1.4 microns. In culture retains its differences from Myzococcus stipitatus. The latter sportlates best at room temperature, but

Myrococcus oralisporus in an incubator (presumably at 37°C).

Source and habitat: Develops on rabbit dung (sterilized) on soil in Poland (Krzemieniewski).

Appendiz: Rippel and Flehmig (Arch. f. Mikrobiol., f. 1933, 229) describe a new type of aerobic cellulose destroying bacteria under the new genus name of Heraonia. This genus includes a single species, Heraonia ferruginea. This organism shows similarity to those included in Myrococcus.

#### Genus 11. Chandracoccus John.

(Jahn, Beitröge zur botan. Protistologie. I. Die Polyangiden, Geb. Borntraeger, Leipzig, 1921; Dactylocoena Enderlein, Bakterien-Cyclogenie, Berlin, 1924, 248.)

Synonymy . A segregate from Myzococcus Thaxter.

Etymology: Greek chandros, grain and kollos, ball (coccus).

Diagnosis: Spores embedded in a viscous slime which hardens. Fruting bodies divided by joints or constrictions, often branched, usually relatively small.

Seven species are included, of which the first described by Tharter and best described, Chondrocorus corallodes (Tharter) Jahn, may be designated as the type The first species listed by Jahn is regarded as doubtful and should not be regarded as the type for there is no evidence that Jahn ever saw the species.

## Key to the species of genus Chondrococcus.

l. Not parasitie on fish.

A. Erect, simple or somewhat branched fruiting bodies.

1. Secondary fruiting bodies not produced.

a. Fruiting bodies constricted or jointed.

1. Chondrococcus coralloides.

an. Fruiting body simple, columnar, elab- or cushion-shaped.

b Fruiting body thick below, lesser above.

2. Chandrocoecus cirrhosis.

bb. Not as in b.

c. Spores 16 to 26 microns in diameter.

d Fruiting body cushion-shaped.
3. Chandrococcus megalosporus.

dd. Fruitiog body branched.

4. Chondrococcus macrosporus.

ce. Fruiting body smaller below, above club-shaped. Spores 1.0 to 1.2 microns in diameter.

Chondrococcus coralloides var. elavatus.

 Secondary fruiting bodies arise as bad-, finger- or coral-like growths from primary fruiting body.

B. Recumbent, simple swelling or cyst heap constituting the fruiting hody.